ZOOGOER

November-December 1988

Building The BioPark

Friends of the National Zoo

is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

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The National Zoological Park is located in the 3000 block of Connecticut Avenue, N.W., Washington, D.C. 20008, (202) 673-4717. Weather permitting, the Zoo is open every day except Christmas. Hours: From September 16 to April 30, grounds are open 8 a.m. to 6 p.m.; buildings, 9 a.m. to 4:30 p.m. Director: Michael H. Robinson.

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Cover: *A major goal of the Biopark is to instill an appreciation of the beauty and majesty of life on earth. The planned Amazonia exhibit will embody this goal, revealing to visitors the beauty and majesty of the Amazon River Valley. (Photo by Ed Bronikowski)*

Drawings on pages 5, 6, 8, and 10 by Warren Cutler/ NZP Graphics. Drawing on pages 28-29 by Julie Olson/ Mosser Design.

ENHANCE

In this special issue of *ZooGoer*, Zoo Director Michael Robinson reveals his vision for the future: to create a new Park, a Biological Park, that surrounds the visitor—surrounds you—with the splendors of the entire biological world. He envisions a Park where you will find tiger lilies as magnificent as tigers, and objects of art to remind us that our natural heritage is inseparable from our cultural heritage. A Park where animals from butterflies to bison, whether on exhibit or native to the Zoo, live among flowers, plants, vines, and trees, all beautifully displayed to delight as well as educate. A Park that shows the natural "connections," for as famed naturalist John Muir observed, "When we try to pick out something by itself, we find it hitched to everything else in the universe."

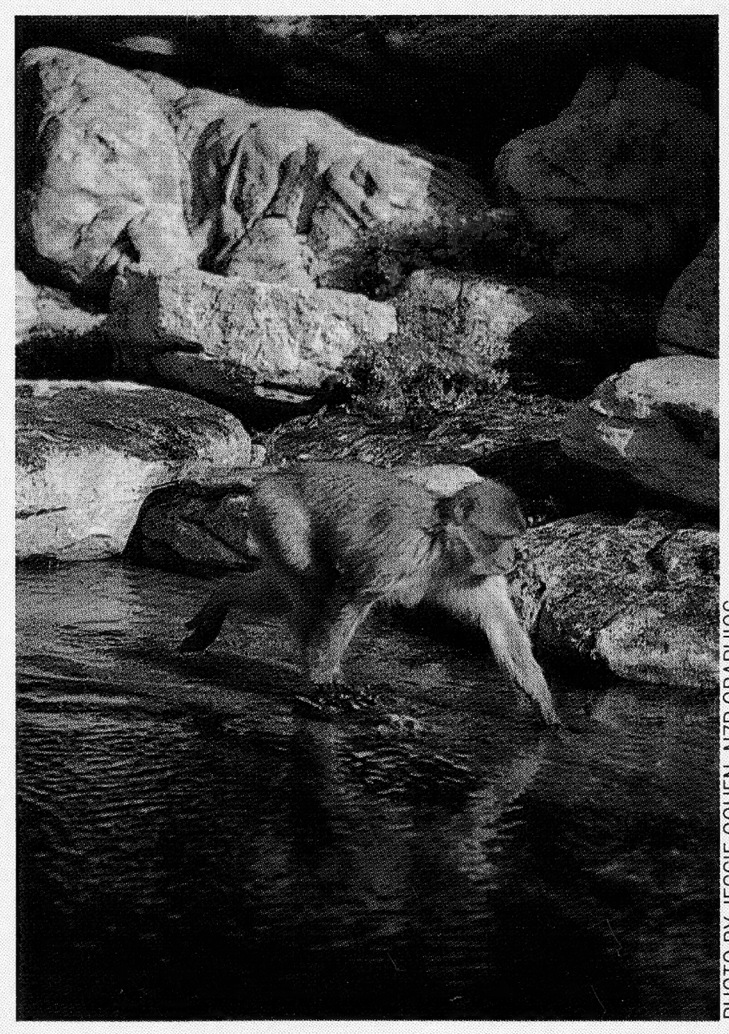

PHOTO BY JESSIE COHEN, NZP GRAPHICS

FONZ enthusiastically supports this vision and to help realize our dream of a Biological Park we are asking for your support through our special new ENHANCE program. ENHANCE is a comprehensive program of financial and volunteer support for building the BioPark. The program has three parts:

ENHANCE Animal Exhibits—to achieve our goal of creating more natural environments for animals and improving the visitor's educational experience.

ENHANCE Park Landscapes—to achieve our goal of exhibiting the flora that in natural systems are inseparable from, and essential to, the fauna.

ENHANCE Arts in the Park—to achieve our goal of illustrating the cultural dimension, including both visual and performing arts, of our biological heritage.

We will soon be announcing the first exciting ENHANCE project in one of these categories, and asking for your contribution. Please watch for more about ENHANCE in the months to come—and plan to help us transform our Zoo into a holistic celebration of the natural world: the nation's first BioPark.

Sincerely,

George A Didden III

George A. Didden, III, President
Friends of the National Zoo

ZOOGOER

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*Tiger Swallowtail (*Papilio glaucus*) on garden phlox (*Phlox paniculata*).*
(Painting by Biruta Hansen, from the poster "Butterflies and their Flowers")

Building the BioPark

Thoughts on the Zoo's Centennial 1889-1989

Michael H. Robinson

When I came to Washington in May 1984 as the newly appointed Director of the National Zoological Park I was full of hope and wonder. I had spent nearly twenty years as a tropical biologist with the Smithsonian's Tropical Research Institute, had worked with exciting animals in exciting countries, and possessed an undimmed sense of marvel at the intricacies of "life on earth." Everything I had done as a biologist filled me with a zeal for transmitting a passion for animal life to a broader public through the National Zoo. This almost missionary enthusiasm was reinforced by having spent many years as a schoolteacher, and also by having acquired a sense of urgency, as a result of living in the tropics, for promoting tropical forest conservation. I was thus prepared, by personal history, to constitute a kind of nodal point for changing attitudes to the mission and function of zoos.

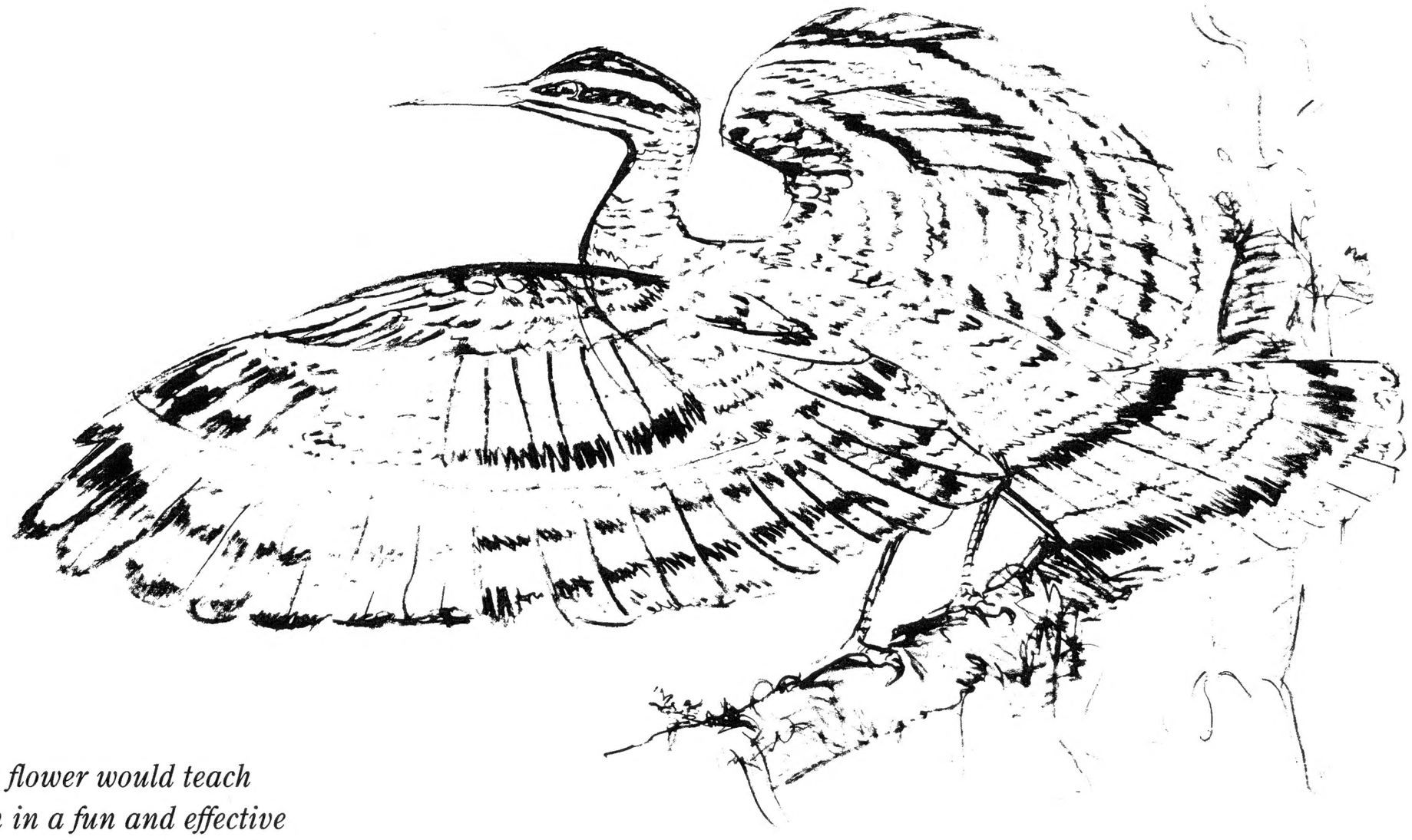
What did I find here in the Washington of the Smithsonian and its National Zoo? I found, quite frankly, an abundance of talent and dedication, and a lack of commensurate progress in the field of exhibits. Under S. Dillon Ripley's leadership, the Smithsonian had made enormous strides in creating new museums and developing existing ones. Of its mandate for "the increase and diffusion of knowledge" it had clearly excelled in increasing knowledge through impressive developments in research. It had created an enormously popular museum dedicated to American contributions to Air and Space technology, a marvelous gallery of Asian art, a magnificent collection of modern art and so on. But the National Zoo had barely kept pace with its needs for modernization, and it remained cast in the conventional mold of most zoos, despite the undoubted talents of both its staff and its driving former director Ted Reed.

Our other great Smithsonian bioexhibit, the National Museum of Natural History, was, in my opinion, almost as reticent in exhibit innovation. And, as I traveled the world, I saw so much progress in museum exhibitry that had not been fully incorporated into our institutions, prominent as they are in the nation's capital. My own feelings about the reasons for this should perhaps be left unarticulated, since they relate to the nature of the budgetary process and its long-term unpredictability.

In part our situation may also be a reflection of an almost worldwide anti-intellectualism that characterizes this period of history. "Private affluence and public squalor" affects museums and zoos as much as universities. It is interesting that the newly appointed Director of the Smithsonian's National Museum of Natural History, Dr. Frank Talbot, has commented that "museums are more popular than ever before, but I don't think our exhibitions fully reflect what we now know about the natural world, including the changes we ourselves have made. Exploring our own world is as exciting as exploring space; that excitement should be reflected in the museum's halls."

However, coming to the Washington scene after many years in the Third World gave me a naive view of it all. I here use naive in the biological sense of uncluttered and unprejudiced, rather than the pejorative use meaning crude and unsophisticated. Just as a new visitor to the tropics takes time to integrate the enormous complexity of information assailing him, so I took some time to sort out the wood from the overwhelming number of trees.

The first dawnings of synthesis occurred not about the Zoo *per se* but about the Smithsonian Institution as a whole. Because I am interested in airplanes, I always spent more time at the National Air and Space Museum (NASM) than I did at the Zoo during my previous visits. It finally dawned on me that although NASM is a glorious gallery of artifacts, where masterworks literally hang like paintings, it does not present a holistic learning experience about the *general phenomenon* of flight. I found myself thinking that both at NASM and at our Bird House we were missing the vital cross-referencing between the world of man-made flight and the world of flying animals. We should be drawing parallels between the two, and emphasizing the holism of human knowledge. North Carolina's claim of "first in flight" is absolute nonsense since the insects were first in the air more than 300 million years ago. They were followed by the reptiles, the birds, and the mammals long before the Wright Brothers made history. Furthermore, the paral-

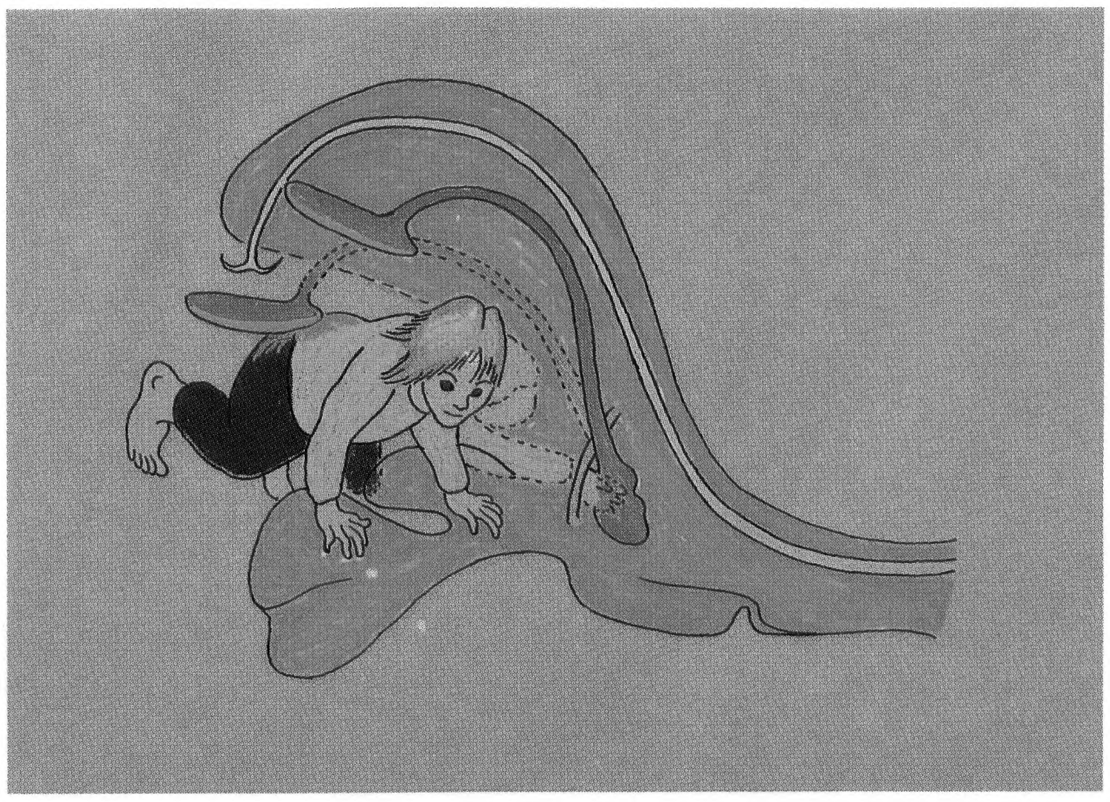


Below: A giant model of a flower would teach children about pollination in a fun and effective way. (Photo by Jessie Cohen/NZP Graphics)

lels between animal wing structures and aircraft are many and exciting.

We have started actually doing something about establishing this link. Paul MacCready's marvelous flying model of a prehistoric flying reptile is hanging at the Zoo; all 18 feet of it! We have this *Quetzalcoatlus northropi* on loan from NASM thanks to the generosity and encouragement of its Director, Martin Harwit, who is an astrophysicist. In addition, as a personal contribution, in pursuit of a lifelong hobby, I am building a museum-quality model of the Wright Flyer to go in our Bird House. In a further step our Invertebrate Exhibit will soon display a lifesize model of a dragonfly with a 28 inch wingspan! Cooperation with Harvard University's invertebrate paleontologist, Dr. Frank Carpenter, made possible the reconstruction of this fossil species from the Carboniferous era of Pennsylvania.

In addition to an obsession with flight, I also started thinking about how the glories of African Art are so frequently tied to African animals, about the role of birds and fishes in Japanese and Chinese art, and how all this could relate to zoos. My first mental steps were clearly small ones, but they opened up an entire intellectual landscape that finished up with that anachronistic entity—the zoo itself. Why do we have zoos for living animals, natural history museums for the structures and past histories of plants and animals, and botanical gardens as separate institutions for plants? Gropingly and slowly, I inched towards the concept of the BioPark as an exhibit entity that combined the functions of the zoo, botanic garden, aquarium, natural history museum, and museum of humankind. Into this ambience we could, through the spice of art, magic, and culture, work to establish the eventual biological experience...the new zoo-that-is-not.



The BioPark

What would we build into our BioPark? I have elsewhere suggested a wide variety of new approaches and detailed these at some length in a number of publications. To illustrate the interdependence of plants and animals, a major BioPark theme, we should create a pollinatarium...a place where flowers and their pollinators are exhibited. This could be a vast conservatory with a year-round profusion of beautiful and complex flowers and their pollinators. Orchids, roses, sages, lupins, hibiscus, and floral magnificence of every kind would coexist with a massing of butterflies, moths, bumblebees, and hummingbirds. Some of the adaptations of flowers to their insect pollinators are almost unbelievably complex. There are orchids, described by Darwin, in which the male parts—called pollinia—actually seize onto the tongues of bees and stick to them, ready to be carried to the next flower. These are mechanisms that should excite our sense of marvel, but how can we illustrate them?

Perhaps we could use model flowers into which children could crawl to do this. They could illustrate some of the more bizarre devices that enable flowers to utilize insects as carriers of their sex cells. It would be the place to illustrate the strange eyes of insects, compare their view of the world with our own and talk about vision at the ultraviolet end of the spectrum. Bees see a color that is invisible to us; a color that has been called bee purple. While we can never see it, we might show people a dif-

ferent view of the world by providing glasses tinted toward the insect end of the spectrum. Better still, we can show humans the ultraviolet patterns on flowers by adapting a television camera to "see" in that wavelength. On a television screen we could see what the bee sees and compare it with our picture of the same scene. Plain yellow flowers, all alike to our eyes, may be striped and mottled as seen by bees. It is like entering a new dimension. All this would really make the point that the appearance of floral beauty was "designed" by evolution, for another audience, and not for us. It would certainly help us towards a proper humility to realize that we are not the center of life, even though we now hold its future in our hands.

A complementary part of this pollination story lies in the "dance language" of the honey bee. This is a system of communication that allows worker bees to accurately convey information about where there are banks of, for instance, wild thyme replete with nectar. The dance tells where, by compass orientation, and how far. It is remarkably sophisticated and can actually be seen in a glass-sided hive.

The "Hall of Floral Sex" would be a good place to deal with odors and floral fragrances. Some of those that are attractive to bees, butterflies, and moths, we humans also find extraordinarily attractive. Honeysuckle is an example. The white flowers and heavy sweet scent attract hawk moths to the flowers at night. But fly-pollinated flowers attract insects that are normally attracted to carrion, rotting meat, and excrement. These are perfect fly nurseries, egg-laying sites for the future generations. Fly-pollinated flowers smell accordingly; attractive to flies but repulsive to the human nose. Poetry has been written about honeysuckle, roses, and wild thyme, but none, to my knowledge about the hellebore or stinking woundwort.

Above: Flowers such as this magnolia inspire poetry, but to other animals they are merely sources of food. (Photo by Milton J. Tierney, Jr.)

And the ultimate bait is not the odor or color, but the resources that the flowers produce for their unconscious agents of sexual conjunction. These are twofold: nectar, the carbohydrate that powers the flight muscles of bees, wasps, butterflies, and hummingbirds, and pollen, the protein that helps build their young. Mankind's long obsession with stored nectar, called honey, dates back into ancient history; bee-keeping is an ancient craft worthy of our exposition at the BioPark. Bees figure in hieroglyphics and the Song of Solomon.

Elsewhere we will illustrate the interactions of plants and animals in seed dispersal and other ecologically significant events. Smithsonian research on the importance of rhinoceros dung-piles to the distribution of Nepalese trees, or the effect of Asian elephants on the flora of Sri Lanka are obvious subjects for exposition.

The BioPark will also illustrate the past of life on earth and the interdependence of the worlds of land and water. Each existing exhibit has a part to play in this, from mammoth skeletons in the Elephant House, to models of saber-tooth cats in the Lion-Tiger Exhibit and the story of man's ancestors in the Great Ape house. A Hall of Humankind could show how our distant ancestors looked, how close we are, genetically speaking, to chimpanzees and gorillas, and all about tool use. NZP's Ben Beck is a world expert on tool use in animals, and we don't take advantage of his special knowledge. This is true also about the results of both NZP and Smithsonian scientific research. We need displays to highlight our contributions to the knowledge about life on earth. Where better to illustrate our comparative studies on the nutritive qualities of milk than next to the mammals that produce it? It all fits together.

I am also convinced that we urgently need to include art in our terms of reference. There is a vast field of graphic art that relates to the world of life. Among the first things that men painted or drew were wild animals. From the caves of Altimira and Lascaux to Australian petroglyphs, animals predominate. Our ancestors were very close to nature and it showed. It came down through the centuries, particularly in Oriental art, and we should show it to our visitors. We should also encourage them to be creative and use our animals as subjects for painting, drawing, and the plastic arts. In addition to graphic art, animals have long been the subject of dance, song, instrumental music, and poetry. People have danced animal hunting and herding dances, modeled rhythms on the courtship behavior of birds, and sung epics about hunts and honey. All this means that the Zoo is a perfect stage for ancient and modern culture. What a place for poetry readings and a Christmas performance of Peter and the Wolf, or the Carnival of the Animals!

All of our planned new exhibits will exploit the BioPark theme. Longtime NZP Director Ted Reed wanted a major aquatic exhibit to be built at the Zoo. The design for this was innovative and technically advanced, but unfortunately fell victim to an unpredictable imposition of budgetary constraints. It would have been a marvelous zoo facility.

One of the striking things about many modern ecosystem ex-

GARDEN DELIGHTS

Butterflies: off Banks of Noon
Leap, plashless as they swim

Over 100 years ago, Emily Dickinson caught the magic of butterflies, their colorful but delicate wings fluttering almost effortlessly in the afternoon sunlight. These tiny creatures symbolize hope and joy to all of us.

Although surprisingly difficult to observe, butterflies are very common; some 85 different species have been identified in the Washington, D.C., area. At the Zoo, many butterflies—including monarchs (*Danaus plexippus*), orange sulfur (*Colias eurytheme*), and tiger swallowtails (*Papilio glaucus*)—mate and lay eggs in trees, shrubs, and weeds throughout the park. But until recently, the adults then flew off because few nectar flowers for them to feed on grew in the Zoo.

This is now changing. Butterflies are coming to the Zoo—and coming to stay, thanks to a new emphasis on butterfly gardening. All over the park, nectar-rich butterfly flowers are being planted in great abundance to attract these beautiful creatures. For instance, butterfly weed, red clover, and common milkweed entice butterflies to the Panda House, the Zebra Yard, and the Lion-Tiger Exhibit during the spring and summer, and butterfly bush draws them from midsummer to frost.

The English Country Garden outside of the Invertebrate Exhibit is one of the Zoo's most colorful spots, boasting such butterfly favorites as New England aster, red clover, butterfly bush, and phlox.

So, the butterflies are back. Everyone is invited to experience the joys of watching these colorful additions to the Zoo's wildlife.

—Lee Gould

To celebrate butterfly gardening and to introduce visitors to the Zoo's butterflies and butterfly flowers, NZP Curator Edwin Gould (with support from the James Smithson Society) has produced a beautiful poster illustrating 10 species of butterflies feeding on 10 different flowers. The poster is available in the Zoo Bookstore.

*Silver spotted skipper (*Epargyreus clarus*) gathering nectar from blue salvia (*Salvia farinacea*). (Photo by Edwin Gould)*

hibits that have been built at "leading edge" zoos is that they generally are built around the concept of *containing* a number of stellar species. Some of the best tropical forest exhibits at zoos in this country and elsewhere are simply constrained, by stereotyped zoo thinking, to be extraordinarily realistic macro-backdrops to the exhibition of zoo animals. They are essentially the jazzed-up or enhanced spiritual or philosophic heirs of the Hagenbeck tradition. One can almost sense the design process: "We'll have gibbons, tapirs, leopards, and hornbills and build the forest around them." The result is a superior exhibit but something that is not entirely biologically valid. The most outstanding feature of tropical forests is *not* the presence of those animals that are at the top of the ecological pyramid. These are sparsely distributed, elusive, and few in number, and seldom seen by the casual visitor. The striking experience in any tropical forest is its small-scale busyness. It is a Breughel's "Children's Games," not a Constable landscape. Recapturing this essence means providing a multitude of active invertebrates, frogs, lizards, snakes, small birds of every kind, and minor mammals at all levels of the forest. It is the exquisite detail that counts, not the broad vistas. For these reasons, the proposed 1978 aquatic exhibit would not have been biologically valid, in the ultimate sense. A tropical freshwater exhibit, such as is contemplated in our Amazonia plan, needs meticulous attention to a smaller scale and a more intricately detailed vision than has so far been achieved anywhere.

Amazonia

Lynn Dolnick, a member of the Zoo's Amazonia design team, is writing about the exhibit elsewhere in this issue. But I must allow myself a line or two on the biological significance of it all. The Amazon is the largest, most complex, and certainly the most species-rich freshwater ecosystem on earth. Its fishes run a glorious gamut in size and specialization, and the bordering forests are the most extensive anywhere. To simulate this biological wealth is an enormous challenge. We have to create an illusion because we cannot match reality.

The illusion is of profusion. There must be many species of fishes, in mighty schools, representing many families. The underwater scenes will scintillate with color, movement, and other activity. The zonation of surface, mid-water, and bottom- living species will be obvious but will also collapse when the whole assemblage boils up into a feeding frenzy. Specialization of form and behavior for defense, feeding, and reproduction need to be highlighted. Flattened discus and angelfishes, leaf-mimicking fishes and pipefishes will all contrast with armored catfishes and hyperactive characins. The scope is immense. Alongside the fishes there are specialized frogs, salamanders, reptiles, birds, and mammals with greater or lesser adaptations to an aquatic way of life. Because these live in a three-dimensional world, they have great mobility which ensures their interest as exhibit animals. From anacondas to anhingas and matamata turtles to water opossums, they illustrate the immense palette of evolution.

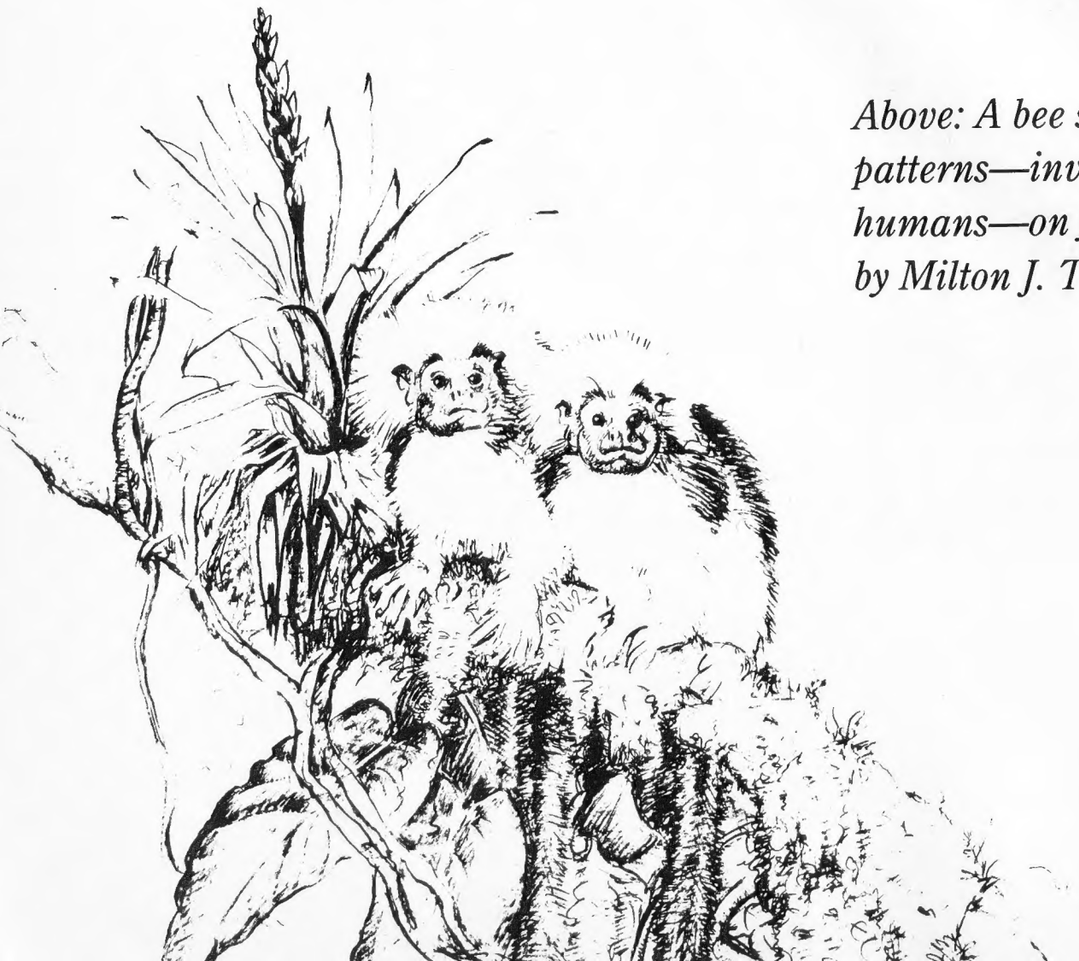
This could all be done in a conventional aquarium but there is a most important connection to be made. It is the inextricable bond between the river and its surrounding and enclosing forest that has never been previously emphasized. Unlike the rivers that wind across the great plains of the temperate regions, tropical rivers, streams, and riffles depend on the terrestrial systems for much of their energy input. The forest shrouds the water and limits its primary productivity. Regularly recurring heavy rains stain tropical streams to the color of mud and further limit photosynthetic activity within the water. So the organisms depend heavily on resources washed in or falling from the forest above.

There is an immense guild of fruit-eating fishes and even the most insectivorous species have stomachs packed with ants, beetles, and other terrestrial insects rather than caddis larvae and mayflies. The teeth of the fruit-eating relatives of the piranha are as fearsome as those of the flesh-eating predator. They serve to bite slices out of fleshy fruits and this is probably a more widespread and reliable resource than animal flesh.

The effect of tropical rains on tropical streams is dramatic, and effectively rings down the curtain on all visual communication for hours. Turbidity is the equivalent of a communication shut-down on a massive scale and it is no wonder that other senses, including electro-reception and transmission, evolved first in these traumatic waters. Any tropical exhibit must have downpours of rain and the rivers must flood. Otherwise we miss one of the hallmarks of the system.

Building the rainforest around the river will be an opportunity and a challenge. In the rainforest there are more species that are involved in more intimate interrelationships than are found anywhere else. Our forest must overwhelm with its complexity. It must present a multitude of intimate glimpses of these relationships. To do this will require innovative techniques in exhibitry, graphics, and video technology. We should be able to eavesdrop on interactions and peer into unique and mysterious corners of a complex picture. For instance, if outlets for video cameras are placed throughout the forest we can watch birds feeding their young at nests, or look into the heart of an ant colony or catch glimpses of shy and furtive creatures at play. Smithsonian tropical research is replete with stories of these "games" among animals and between animals and plants.

The forest must also be seasonal, it must illustrate the phenomena of leaf-fall, flowering, and fruit-fall which are such strik-



Above: A bee sees ultraviolet patterns—invisible to humans—on flowers. (Photo by Milton J. Tierney, Jr.)

ing effects in the yearly drama. It must smell right and sound right. There would be a marvelous possibility for nocturnal visits to the rainforest exhibit, for then an entirely different assemblage of animals takes over.

It should also put man into the system since this is not an innocent paradise but one where Amerindians have lived for thousands of years in relative harmony with nature. It is also, now, the most endangered natural system on planet Earth. Amazonia could be a culminating BioPark experience.

Australian Pavilion

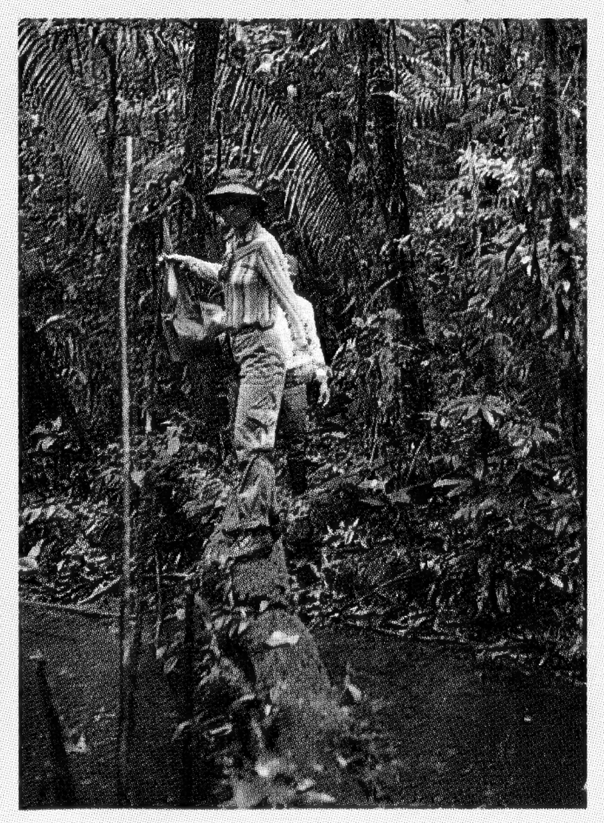
This is how the new approach could be applied to a single, complex, and undivided exhibit space. We can also apply it to a more conventional pavilion. For instance, an Australian exhibit would provide a unique opportunity for advanced thinking. This largest of all islands is also a biological oddity, a fragment of evolution preserved at the marsupial level, with an unusual flora and an amazing geographical and geological history. Its colonization by modern man disrupted an unusual aboriginal culture and had pro-

AMAZONIA

The Amazon River Valley is coming to the National Zoo. Planning is underway for the largest, most complex exhibit the National Zoo has ever built—Amazonia. Amazonia will be a tropical rainforest exhibit, and more. Visitors will be able to see the beauty of the forest and wonder at its complex workings, discovering for themselves what makes this ecosystem one of the most exciting places on earth. Inside a glass dome on the site of the old polar bear exhibit, a slice of the Amazon river system with its surrounding forest will flourish, with towering trees and a staggering array of plants and animals.

In an adjoining series of galleries, the visitor is invited to explore the small-scale wonder that is the true glory of Amazonia. All aspects of the forest will be there—the myriad small creatures that make up the bulk of life in the forest; the interactions of plants and animals, and of water and land; indigenous peoples' use of the forest; and the life cycle of the forest itself.

No institution in the world has more scientists studying more aspects of the tropics than the Smithsonian, and we are taking advantage of that. As visitors explore Amazonia, they will be guided as if by such a scientist—reading field notes, observing experiments, reviewing all the fascinating things tropical research has revealed. The visitor will also share the scientist's sense of humility, because so much remains to be learned, so much is not yet understood about the complexity of life in the tropical rainforest.



A Quick Tour

Amazonia is at present a set of designs on paper, but you can take a mind's-eye tour of the exhibit.

You enter Amazonia as if entering the field station of a Smithsonian scientist. The forest in front of you is hot, humid, lush, and alive with activity. Tiny monkeys twitter overhead, a snake curls on a branch. A waterfall, giant trees, and a river with cavorting otters and waterbirds dominate the landscape. The deck is outfitted with the tools of science: binoculars are aimed at three-foot-long nests hanging in a nearby tree; an insect trap rests next to a remarkable collection of beetles, butterflies, and other specimens. The shore of the river teems with a variety of Amazonian wildlife.

You then dip underground for a different perspective on life in the mighty Amazon River. Underwater, you will see the remarkable diversity of life in the river: Big fish, little fish, fish as primitive as dinosaurs, great schools of brilliant red and blue fish, birds, otters, caimans, even snakes swirl before your eyes.

You leave this grandeur behind to take a closer look at the activity of the forest and the complex worlds within worlds that make the tropics unique. In a series of galleries, you will discover that the forest is studded with treasures such as birds' nests, tadpoles, giant walking sticks, orchids, scarlet mushrooms, rabbits, and pacas.

These galleries are also scientists' work stations, where experiments in progress provide insight into the workings of this ecosystem. A magnifying glass reveals an ant colony living inside the thorn of a bush. A weather station shows the climate patterns of the tropics and suggests reasons for the variety of life forms here. A special camera reveals the dramatically different way an orchid looks to a bee.

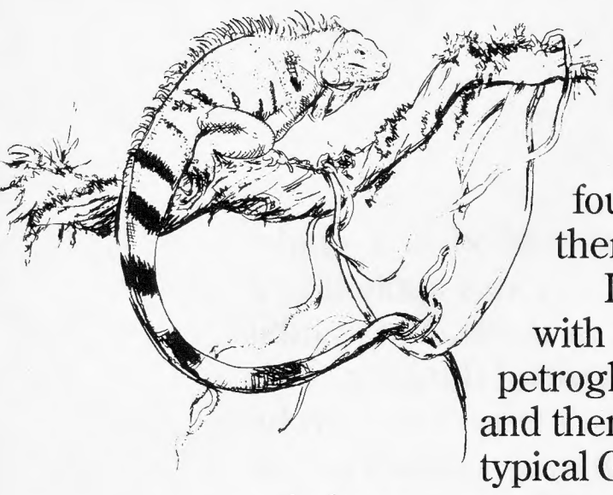
The galleries also feature touch-screen computers and video discs that show wonders of the jungle captured in time: a giant water bug catching a fish; a spider weaving her web; birds hatching from eggs. Also available for examination are vast collections of seeds, fruits, feathers, and insects, which illustrate the diversity of forest life. The contents of these galleries will change from time to time, illuminating the vast world of the Amazon.

Through your tour of Amazonia, we hope you will acquire a new perspective on life in the tropics and how science strives to understand it; that you develop a compelling sense of the jungle's interwoven life forms that make it a single giant organism with many parts, and at the same time make the tropical forest frighteningly fragile. Above all, we hope you will leave the National Zoo with a deeper appreciation of the beauty and majesty of life on earth and an understanding that animals, including humans, are part of an intricate web of interdependence and interaction.

This is the heart of the BioPark concept, and Amazonia will embody it. Construction of the exhibit will begin next spring and will take several years to complete. It is an ambitious undertaking, but ambition is what makes great things happen—and great things are worth waiting for.

—Lynn Dolnick
Special Assistant to the Director

In Amazonia, visitors will feel like they are exploring the rainforest. (Photo by Ed Bronikowski)



found effects which are better documented there than anywhere else.

Imagine an Australian pavilion that started with reproductions of some of the Aboriginal petroglyphs, from the Great Snake to kangaroos, and then led into a stunning underwater view of a typical Great Barrier Reef community. The barrier reef phenomenon, explained by Darwin, allows the exhibit designer to show that biology can profoundly affect geography. Within the same house would be examples of the explosive radiations of the marsupials within this region. Wallabies, wombats, marsupial "mice," "shrews," "cats," and anteaters are all part of this story. They can be set against the unique flora of Australia where Eucalypts have an extraordinary richness of species and cycads flourish. Australia has more species of insectivorous plants, particularly sundews, than any other region. The freshwater fishes are few in species but make an impressive display. Since the biological affinities of Australia, southern South America, southern Africa, and Antarctica provided some of the first clues to the existence of continental drift, any exposition on Australia should highlight this phenomenon, probably with drift-apart models of the land masses to illustrate plate tectonics. An Australia exhibit would not be complete without some of the unique birds and reptiles. Finally it should include an exhibit on the man-made ecological disaster that resulted from the introduction of the European rabbit into the marsupial-dominated landscape.

The famous rabbit-proof fence beautifully illustrates the Great Wall of China defensive syndrome. I think that this would also be an appropriate place to stage a demonstration of sheep-dog training and working. Man's long association with the dog probably originated in cooperative hunting, and the use of sheepdogs in the vastness of the outback effectively capitalizes on hunting behavior to control large masses of sheep which would otherwise be extraordinarily difficult to manage. The lesson here would emphasize how animals learn, and how we have used their capacities to do so for our own benefit.

New Goals

Mentioning dogs raises another issue. Humankind's long association with animals includes not only art, magic, and religion, but also, of course, our domestication of many species starting with the dog in Neolithic times. In the course of this association—which ranges from carnivores like the dog and cat, through herbivores like horses, cattle, sheep, and goats to the wide variety of birds—we have created many breeds or varieties that are, like numerous species of wild animals, in danger of extinction. I think that many of these animals are worth preserving for their beauty and interest as well as for their potential utility. We have started to exhibit some of these interesting animals and may do more in the future. The Vietnamese pot-bellied pig is one example.

I have another dream to realize that is part of, but at the same time beyond that of building a more holistic biological experience. This dream also includes but extends beyond that of trying to play our part in cross-referencing human knowledge by cross-referencing the Smithsonian. This aim is to widen our audience to include those groups of people who now, for whatever reason, are not moved by the wonder and beauty of life on earth. If life is to survive in all its diversity, we must be moved to protect it. This is an aim that we need to promote as widely as possible. We have not yet succeeded in this.

I am also conscious that we must do more to cater to the needs of the numerous children in our audience. Special child's-eye viewpoints are needed at our exhibits. I constantly see parents lifting their children into laborious positions in order to give them a glimpse of the animals. As a result of this, I see children interacting with the squirrels and pigeons that are at their level rather than with the elephants. That is not our only deficit as far as children are concerned. We do not have explanatory graphics for children, suited to their height or level of understanding, a level that involves curiosity and little prejudice. Nor do we succeed in engaging the sense of make-believe and play that characterizes childhood. This is a fundamental deficiency. Despite the imaginative character of our family learning centers and their pioneering success, we ignore children in general. We need to take the spirit of Birdlab, Herplab, and Zoolab out into the park. The innovative new concept of the Children's Trail and Rabbitat will do that someday. But in the meantime we can't afford to wait for these to be funded and built. We must act now on the things that can be done without massive funding to make the Zoo more of a children's delight. To do so is to capture the future generations for the future of life on earth. Otherwise, a substantial proportion of our children will grow up with attitudes that are ecologically disastrous—attitudes developed from the Rambo-like kill 'em, stomp 'em characters that they encounter *ad nauseum* on children's TV.

All these hopes and aspirations, plans and prospects, are part of our future that can be realized. If we are to realize even a fraction of these aims, the role of FONZ will become even more crucial. It is clear that the spirit that now activates so many dedicated volunteers is a spirit of concern for the living planet and the glory, beauty, and wonder of animal life. We cannot build the future on anything else. Synergism between our two "bodies" at the National Zoo, as inseparable as two sides of a coin, is the foundation for building excellence. These examples of what I hope for in the next few years show how a holistic approach could add new elements to biological education as we move from a zoological park to a BioPark approach. It would all help our sense of balance. Best of all it would be immensely satisfying to be able to move ahead on our new major projects; their construction here in Washington could truly advance our mission for the "advancement of science and the instruction and recreation of people." Those words of our 1889 charter are almost as wise and perceptive as James Smithson's injunction that the Institution he created was to be for "the increase and diffusion of knowledge." We could celebrate our centennial by fulfilling *his* dream and *our* dreams... simultaneously.

In the Amazon, river and forest are inextricably linked. (Photo by Ed Bronikowski)

THE GREAT UNWATCHED

Urban Wildlife in the Zoo

Miles Roberts

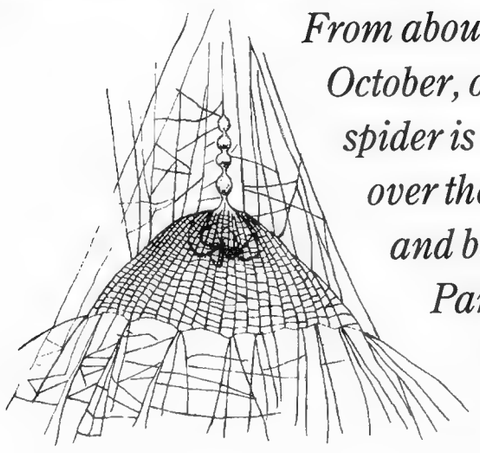
*Wood thrushes (*Hylocichla mustelina*) breed in city woodlands. (Photo by J. R. Woodward/VIREO)*

Cities are for people. They grow upward and outward in response to uniquely human needs: commerce, housing, and the infrastructure that supports them. But over the last few decades many cities have seen urban development sprawl out of control as natural or semi-natural areas are replaced with man-made edifices. Like people throughout the country, residents of our local communities, such as Friendship Heights, Tyson's Corner, and Silver Spring, are questioning and resisting these trends, arguing that a once good idea has gone too far.

The motives for citizen resistance are well known: Natural areas within urban areas are a basic need of city dwellers, and central to their enjoyment of city life. As malls, parking lots, and high-rises replace natural areas, the quality of life deteriorates and at some point most residents become willing to sacrifice economic benefits for aesthetic ones. For many people, the presence of wildlife in their city represents a significant aesthetic benefit.

To give people the wildlife they want, we must be willing to devote space in our cities to woodlands with balanced natural communities of plants and animals. And the larger the woodlands, the better. Lessons from

*Red-tailed hawks (*Buteo jamaicensis*) nest on Zoo grounds. (Photo by Benjamin Boblett)*



From about May to October, one species of spider is dominant all over the small trees and bushes of the Park. This orb-weaver, Mecynogea lemniscata, *builds a very unusual web for catching prey. The web is an inverted bowl with a fine, almost square mesh that is not sticky and takes a long time to build. Because it has no glue on it, the web is long-lasting and may be in the same place for months. The spider sits on the underside of the dome at its top and from there attacks prey through the web. Insects strike the tangle of threads around the bowl and drop onto it. The spider strings its eggsacs above the dome, and its success can be easily measured by counting them. (Drawing by Jeff Boyd.)*

biogeography show that the diversity and number of species that can live in an area are directly related to the area's size. Vegetation diversity also affects the presence of wildlife—especially of the birds and mammals most obvious to people—because so many animals are linked to specific plants or plant communities.

After size, perhaps the most important factor influencing wildlife diversity in a park or natural area is its proximity to a natural reservoir of wildlife. Small, isolated patches will support a small number of individuals of a few species, most of which will be urban survivors such as house sparrows and pigeons. In contrast, large patches near large reservoirs are more likely to support diverse species of the kinds that lift the spirit of the city dweller.

In Washington, D.C., we are lucky to have a very large—by city standards—reservoir for wildlife: Rock Creek Park. The Park forms a natural vegetation corridor between the suburbs and downtown, and until quite recently was well connected to essentially undisturbed areas in Maryland and Virginia that were themselves wildlife reservoirs for the Park. Right in the middle of the Park is the National Zoo.

Over 70 species of trees and countless species of shrubs, wildflowers, vines, groundcovers, and "weeds" grow in the Park. The forest, dominated by deciduous hardwoods, consists primarily of oak, hickory, tulip poplar, flowering dogwoods, and beech. The topography is steep, ledgy, and rock strewn, serving as a drainage for the creek. Some areas are open and landscaped, while others are dense, deep, and tangled. The character of the Zoo section—about 160 acres—lies somewhere in the middle.

The native wildlife of Rock Creek Park and the Zoo is a small subset of the region's wildlife assemblage. For instance, of the 200 or so species of land birds native to the Delaware/Maryland/Virginia region, only about half have been seen recently in Rock Creek Park. Of these, only about two-thirds breed here regularly.

Local bird species fall into roughly three classes, depending on their tolerance of local conditions. Highly tolerant species include mourning doves, blue jays, tufted titmice, catbirds, song sparrows, and house wrens. These species are relatively insensitive to the amount of available vegetation, and are often found in urban and suburban gardens. Moderately tolerant species, such as common flickers, downy woodpeckers, common crows, American redstarts, and goldfinches, reside in areas with dense and consistent vegetation. Finally, intolerant and thus rare species, such as ruby-throated hummingbirds, meadowlarks, indigo buntings, and swamp sparrows, become residents only when their exacting needs are met.

The Zoo's diverse mosaic of forest, shrub, and lawn patches encourages bird species diversity, making it possible to see warblers, nuthatches, vireos, wrens, and tanagers—all typical forest dwellers—within a few hundred feet of robins, house finches, blue jays, and mourning doves, all more typical of suburban gardens.

And there are a few surprises. In recent years, such unexpected guests as belted kingfishers, pileated and red-headed woodpeckers, red-tailed hawks, and saw-whet owls have established nesting territories in the Zoo. Quite a few other rare residents at least stop over at the Zoo on their way to or from preferred breeding grounds and in spring and autumn, the National Zoo is one of the best places in urban D.C. to add birds to one's life list. Most of this action takes place in the wooded areas along the bikepath and the creek, where spring buds and flowers and autumn seeds and fruit attract the migrants.

Of the 60 or so species of mammals that have been reported in Maryland and Virginia, only about a dozen are common at NZP and only two, the gray squirrel and the eastern chipmunk, are commonly seen by the casual Zoo visitor. These two bold scavengers are actually more abundant on the Zoo grounds than in less disturbed parts of Rock Creek Park because they thrive on handouts, spilled popcorn, and tidbits stolen from the ani-

mal enclosures (sometimes at great risk!).

The ubiquitous gray squirrels can be seen foraging and caching bits of food the year round, even in the depths of winter. Two unusual color varieties of this species, the black or melanistic phase and an albino, can be seen in the Zoo. In 1906 about 10 black squirrels from Ontario were released at the upper end of the National Zoo, beginning an interesting, if accidental, demonstration of how the Zoo works as a reservoir. In the 82 years since that release, melanism has spread throughout the squirrel population of the city and into the Maryland suburbs. It doesn't seem to have reached Virginia, because the only route is across bridges clogged with joggers and traffic. The albino squirrel has been a resident for a few years and plies the lucrative popcorn route between the Bird House and the Mane Restaurant where she is often seen approaching a child with something good to eat. Albinism, in this as in other species, is very rare and the trait does not appear to be spreading.

The Zoo's other common wildlife character—the eastern chipmunk—sports slick racing stipes down its back. Between December and March the chipmunk stays underground, living off cached food; during the rest of the year it frequents every part of the Zoo where suitable cover exists (two chipmunks even took up residence in the Great Ape House).

For the past two years I have studied the chipmunks between NZP's Monkey House and the Research Building across the Creek. Marking approximately 150 animals with colored eartags has enabled me to track individual life histories, habitat preferences, and the effect of habitat types on reproductive success. Predictably enough, those chipmunks lucky enough to have territories near exhibits (leftover animal food), restaurants (human food scraps), and picnic areas (whole sandwiches!) are bigger, have more babies, and live longer than the poor creatures stuck out in the woods. So much for "natural" selection!

The larger species, like the red and gray foxes, raccoon, and opossum range throughout the Zoo and are commonly found in other parts of the park and, occasionally, the city itself. Except for foxes, which shy away from close contact with humans, these animals will make themselves at home in attics, chimneys, garages, or rock gardens as well as in more natural haunts, such as tree hollows or under fallen logs. Smaller species tend to have more particular needs. The white-footed mouse, meadow vole, and short-tailed shrew are all common in the Zoo but in different locations. The mouse prefers woodlands with underbrush and fallen logs; the vole more open, grassy areas; and the shrew is drawn to thick, moist leaf litter. Other common but rarely seen Zoo dwellers are the flying squirrel and little and big brown bats, which flit above the Creek at dusk on summer evenings. All these species are nocturnal and hard to find unless you know where to look. Occasionally, a beaver, muskrat, or white-tailed deer will wander out of Rock Creek Park and into the Zoo, but they usually don't live here year-round.

Ironically, the species we wish would leave the Zoo just won't go, despite all kinds of encouragment. House sparrows, starlings, house mice, Norway rats, and other "pests" take more than their share of food and spread disease among the collection animals. They also compete with more desirable native wildlife for food and shelter and leave a mess wherever they go.

If we want to continue this pleasant mixture of native and exotic fauna, our local ecosystem must be intensively managed. The Zoo is a perfect example of a multiple-use park and is in many respects a microcosm of our national parks. Like them, our Zoo serves people and wildlife, recreation and conservation, and meeting these needs requires a delicate balancing act. For example, what is to be done with a dead tree standing near a pathway through the Zoo? The tree would be dangerous to visitors, should it fall, but cutting it may deprive a wild resident of food and shelter. Of course, cutting the tree and planting a new one in its place to benefit future wildlife generations is the pragmatic decision which serves both ends. Most human-wildlife conflicts are not so easily resolved, but by using the same care and wisdom we devote to conserving the exotic animals in the Zoo and in the wild, and a bit of luck, we may be able to balance both sides of the equation, so that our native and exotic charges may live at the Zoo side by side for future generations to enjoy.

An albino squirrel is a popular Zoo resident.
(Photo by Jim Lynch)

Research mammalogist Miles Roberts can often be seen stalking the grounds of NZP in search of the wild chipmunk.

The Pleistocene Zoo

Next time you visit the beaver exhibit at the National Zoo, let your imagination wander. Picture a beaver similar to the one you see, but weighing nearly 450 pounds and stretching more than eight feet from head to webbed foot. A beaver, in fact, about the size of your average black bear.

Until perhaps 10,000 years ago, such a beaver ranged throughout eastern North America. Inhabiting lakes and ponds bordered by swamps, the giant beaver (*Castoroides ohioensis*) was a strong swimmer but appears not to have built dams or felled trees. The giant beaver and the modern beaver (*Castor canadensis*) overlapped in distribution during the Pleistocene, and competition between the two species may have contributed to the giant's extinction.

Had the natural history of the Zoo been written 15,000 years ago, near the end of the Pleistocene, a variety of mammals still common in the Zoo and nearby natural areas would have been mentioned. White-tailed deer, raccoons, red squirrels, Eastern chipmunks, black bears, beavers, and bobcats ranged in what was then an area of open coniferous parkland. Also noted would have been many other familiar North American mammals whose range no longer extends into this area. For instance, coyotes, grizzly bear, caribou, elk, wolverine, badger, and bison inhabited this part of the world. In fact, some of these species, such as the grizzly bear and coyote, persisted in the eastern United States until colonial times.

The Pleistocene Zoo's natural fauna also included at least one other species still seen here—but only in exhibits. Jaguars—larger than the modern form but of the same species—prowled the area in search of prey. The presence of jaguar, however, may have excluded the American lion—a larger version of the same lions now largely confined to Africa—which were common in the rest of North America until the end of the Pleistocene. But like the giant beaver, most of eastern North America's spectacular Pleistocene megafauna is entirely extinct.

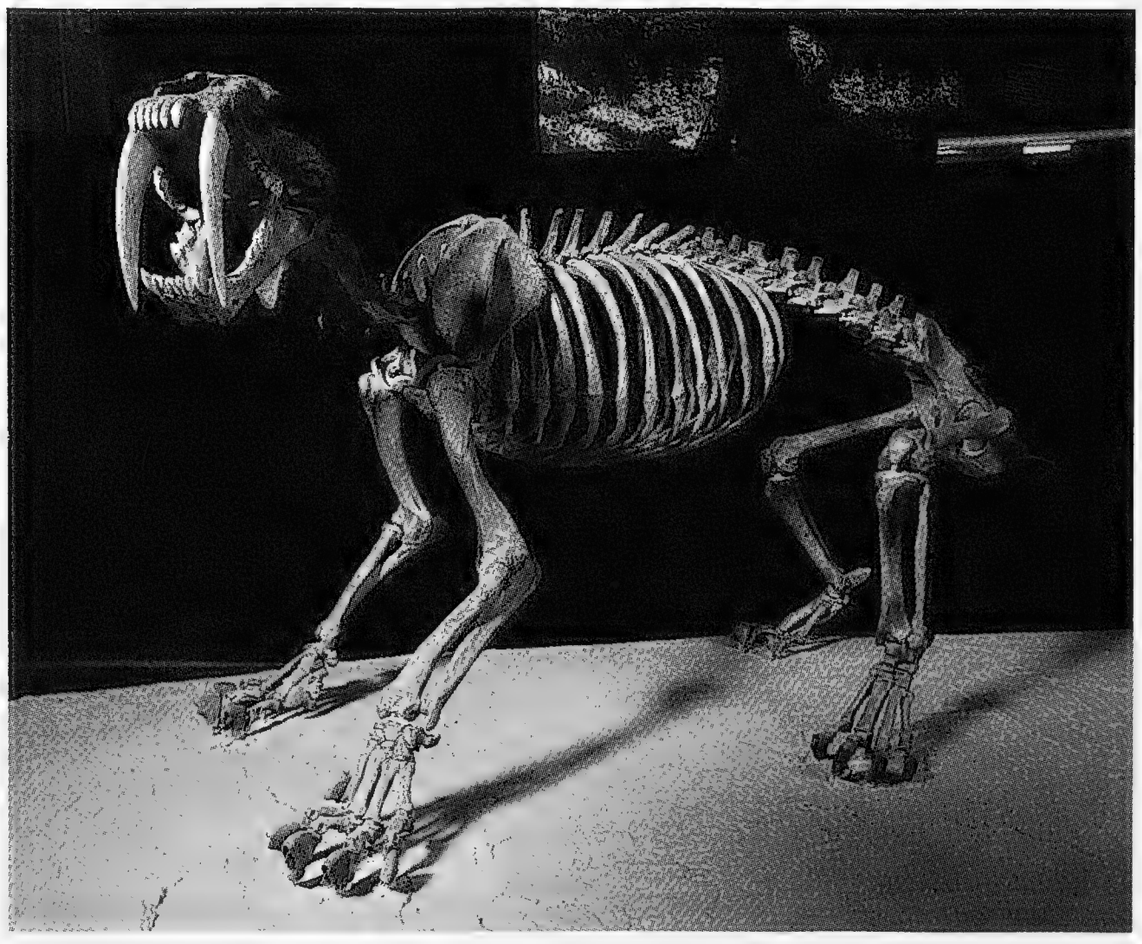
The huge American mastodon (*Mammut americanum*) ranged throughout North America but was particularly abundant in the spruce woodlands of the east along the Atlantic Coast, where it fed on the twigs and cones of conifers as well as leaves, grass, and swamp plants. Standing nine feet at the shoulder, and with massive curving tusks up to eight feet long, these mastodons were exceeded in size only by their distant relatives, the mammoths (*Mammuthus*), one species of which may also have ranged in this part of the United States.

Another large herbivore was Jefferson's ground sloth (*Megalonyx jeffersoni*), which reached the size of an ox. Its very long forelimbs, which ended with enormous claws, may have been used to pull down branches to browse on, while the animal balanced on hind feet and strong tail. Thomas Jefferson named this species *Megalonyx*, or "great claw," at first believing he had discovered the claw of a monstrously large carnivore. He was soon convinced, however, that the animal (later named in his honor) was actually a relative of other extinct ground sloths and the tree sloths of South America.

Despite their large size and formidable claws, Jefferson's ground sloths were probably prey to a variety of predators, including sabertooth cats (*Smilodon fatalis*), dire wolves (*Canis dirus*), and giant short-faced bears (*Arctodus simus*). Widespread in North America during the Pleistocene, the giant short-faced bear was the largest bear (its weight is estimated at 1,500 pounds) and most powerful predator of its time. In contrast to living bears, this species was slim and long-legged with a cat-like head. These features suggest it was agile and fast, well able to prey successfully on the diverse Pleistocene herbivores, which also included now-extinct musk-ox, peccaries, tapirs, deer, and even one species of horse.

A fortunate visitor may spy a fox or white-tailed deer roaming the Zoo grounds, but of extinct Pleistocene mammals, only the ghosts remain. For those wishing to see such creatures in the bones, if not the flesh, a visit to the Ice Age Mammal exhibit at the Smithsonian's National Museum of Natural History might just be the next best thing.

—*Susan Lumpkin*



Skeleton of extinct sabertooth cat. (Photo by Chip Clark/National Museum of Natural History)

ANIMAL, VEGETABLE, MINERAL...

A Zoo Scavenger Hunt

When you visit the Zoo, you probably come to see the animals. But have you ever found a dinosaur? Knocked on a rock? Smelled animal perfume? Then try our Scavenger Hunt to discover things you never knew you could do at the Zoo!

Instructions: Follow the arrows on the map, stopping at each symbol to hunt for the animal, vegetable, or mineral suggested by the clue. If you do the Scavenger Hunt before January 31, you will receive a certificate and a free box of popcorn! To get a certificate, show your Scavenger Hunt at the Information Desk in the Education Building before you set off. Then, midway through the Hunt, show your certificate at the Mane Restaurant (or the Pop Stop) for a free box of popcorn.

1. Find a half-size model of a flying reptile that lived during the age of dinosaurs, more than 64 million years ago. _____

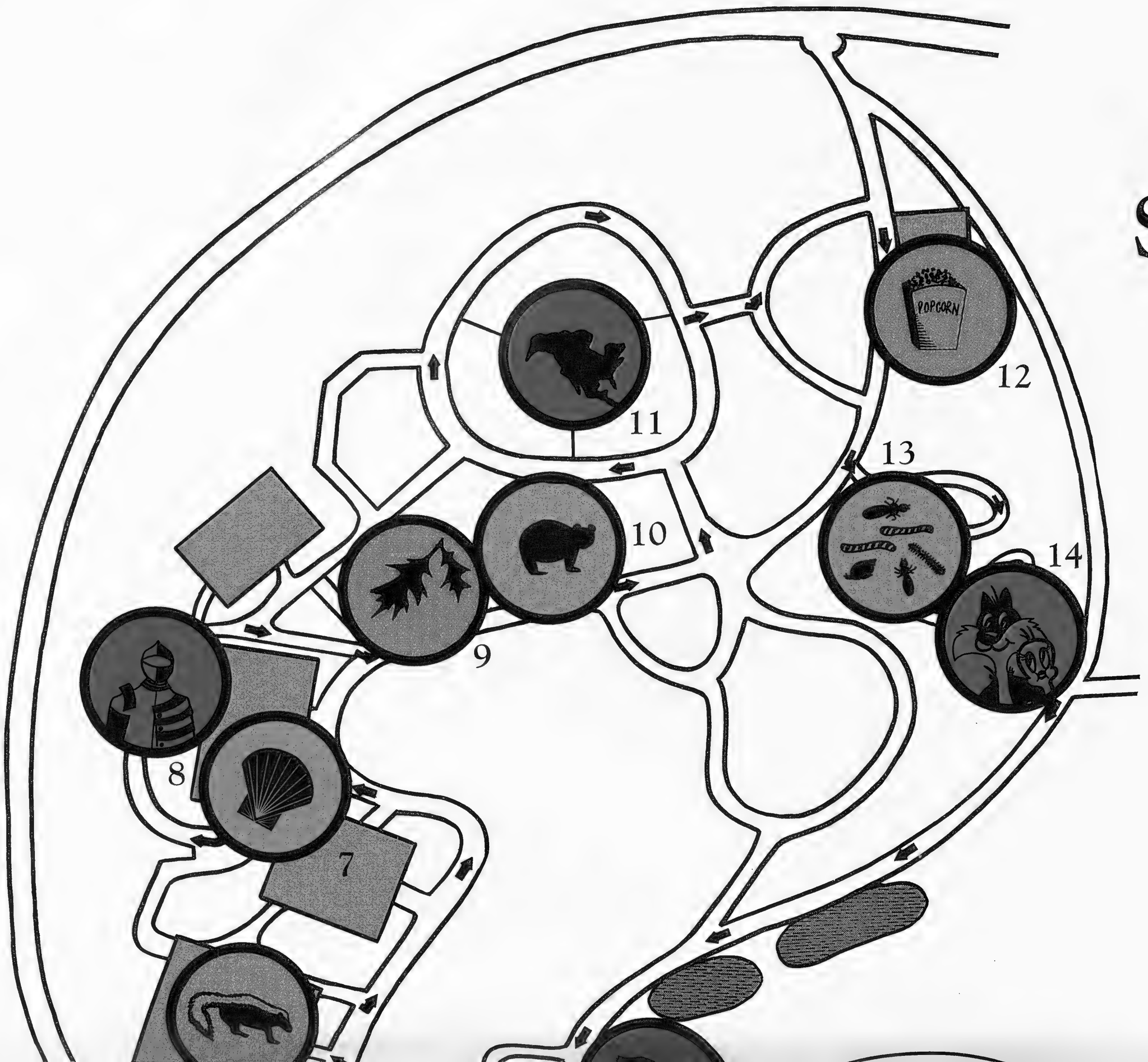
2. Over time, the flowers of different plant species have evolved to attract the insects and birds that pollinate them. For instance, the nectar and pollen of certain flowers draw butterflies in search of food. Can you find three or more plants grown at the Zoo to attract butterflies? _____

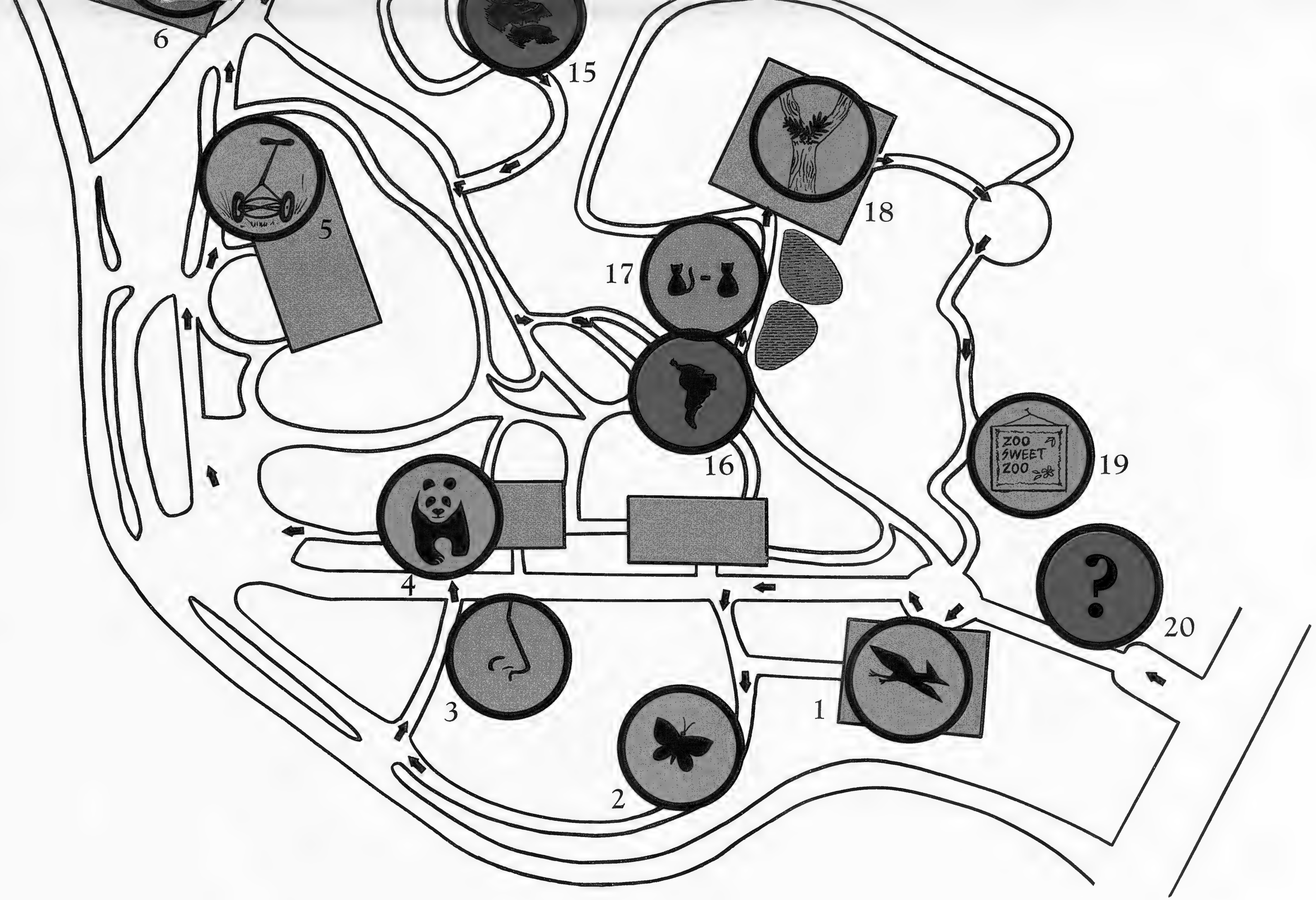
3. Much as we depend on our sight, many animals rely on their sense of smell to learn what's going on around them. Follow your nose to find an animal that marks its territory with strong-smelling "perfume." _____

4. Find a portrait of the naturalist who was the first Westerner to "discover" the giant panda. He was a French missionary in China in the 1800s. _____

5. According to African legend, God created one animal to mow the grass for other animals. But this beast wanted to live in the cool water, and God was afraid that it would eat fish instead of grass. At last, God allowed the animal to stay in the water, but only if it would come out at night to eat the grass. To make sure the animal wasn't cheating, God ordered it to spray its dung to prove that there were no fish bones in it. Name the two-ton, water-loving beast of this legend. _____

ZOO SCAVENGER HUNT





Art by Sriyanie Miththapala

6. The North American striped skunk searches by night for food such as mice. When disturbed, it raises its tail as a warning and may spray its musk in defense. Find an African animal that looks like a skunk, smells like a skunk, but is not a skunk. _____

7. The columns at the entrance to the Reptile House are made out of marble. Millions of years ago, this rock was on the ocean floor. There, fragments of seashells were trapped in the rock as it was formed. Even though the marble has been through many changes since then, you can still see some fossils in the columns. Can you find any? (The marble columns are rough because acid rain has eaten into the polished surface.) _____

8. Some creatures, like humans and fish, are supported by skeletons inside their bodies. Other animals, like crabs and insects, have exoskeletons—hard parts on the outside instead of the inside. This protects their soft bodies like suits of armor once protected knights. Find a knight in shining armor. _____

9. Exhibits in zoos usually have labels to help you name the animals. Here, many trees also have labels. Can you find at least three different kinds of oak trees in the Park? _____

_____

10. From prehistoric cave paintings to modern wildlife photography, animals have inspired many artists. Can you spot four different bear sculptures around the Park? Hint: They are all in the same area—if you get stuck, look up! _____

11. Which large African cat roamed North America (as well as South America, Europe, Asia, and Africa) 12,000 years ago? Hint: They live in groups. _____

12. Stop and show your Scavenger Hunt certificate at the Mane Restaurant(or the Pop Stop, across from the Small Mammal House) to get a free box of popcorn.

13. Can you find a spot where termites, millipedes, snails, slugs, moss, fungi, slime molds, and small plants live and make natural "fertilizer"? _____

14. Many animals have developed remarkable defenses to keep themselves from becoming food for other animals. But even the most effective defenses may not stop all predators. In side-by-side exhibits, find an animal with a prickly defense and a predator that isn't stopped by it. _____

15. Many zoo exhibits are built from artificial rock—a mixture of fiberglass and cement. One side of the main window of the small-clawed otters' Beaver Valley exhibit is a real rock, called Kensington gneiss. The other side is man-made. Which is which? Hint: Artificial rock sounds hollow. _____

16. Scavengers, such as vultures and hyenas, are animals that eat carrion, or dead animals. Find a South American scavenger. Hint: It has a bald head like two other scavenging birds, the condor and the marabou stork. _____

17. Find a cattail—minus the cat. _____

18. In the tropics, many plants, vines, and fungi grow from the branches and trunks of trees. They are called epiphytes. Can you find an exhibit where real tropical plants grow from an enormous man-made tree? _____

19. Find an animal that lives only in zoos. Hint: It's named after the French naturalist who discovered them in a royal Chinese park in the 1800s—they were extinct in the wild even then. _____

20. One species seen throughout the Zoo threatens the future of life on earth through its activities. Name this most dangerous mammal. _____

by Mary-Russell Roberson and Susan Weinberg
(Answers will be printed in the January-February 1989 issue.)

Beneath It All

Mary-Russell Roberson

As visitors enter the National Zoological Park, many stop to admire the view from the Glockenspiel northeast to the Mount Pleasant neighborhood. Studying the map posted beneath the Glockenspiel, some may notice the hairpin path Rock Creek traces around the Zoo grounds and wonder how it came into being. Later, trudging up the steep walkways, perhaps pushing a stroller filled with baby and accessories, many grumble about Zoo's hilly grounds. And an occasional visitor may stumble upon an unusual exhibit, which is neither zoological nor botanical, but geological.

Each of these phenomena illustrates how the geology of the region has shaped and continues to shape the Zoo and the city itself.

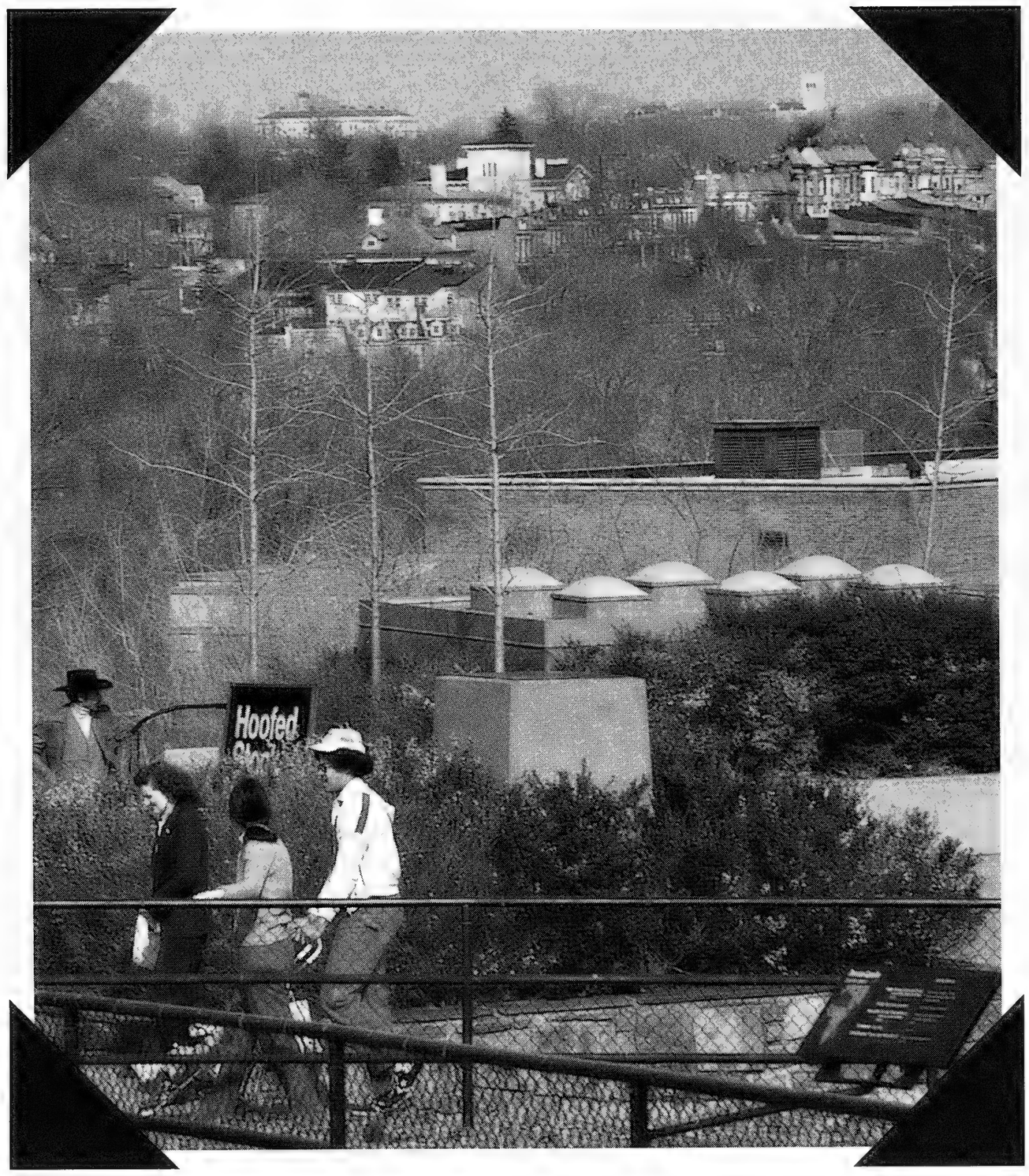
Washington straddles the boundary between two major geographic provinces—the Piedmont and the Coastal Plain. The rocky, hilly Piedmont stretches all the way from New York City to Montgomery, Alabama, varying in width from 25 miles in the Washington area to 125 miles in North Carolina. Geologically, the Piedmont consists of ancient rock—averaging 400 to 600 million years old—altered (metamorphosed) by millions of years of heat, pressure, folding, and faulting deep in the earth. Much of it has weathered to clay at the earth's surface.

To the east, the Coastal Plain consists of much younger sands, clays, and gravels, laid down from 10,000 to 100 million years ago. Over this timespan, the rivers and sea alternately built up the thick layer of sediments: When the sea was high, it deposited sediments; at other times, rivers deposited weathered rocks, sands, and clays picked up on their journey through the Piedmont.

The Piedmont's hard rock resists uniform erosion. Rivers, rain, gravity, and wind eventually eat into even the hardest areas, but cut more quickly and deeply into weak spots like folds, cracks, and other isolated areas of soft rock. This type of uneven erosion makes for a hilly landscape, which contrasts with the low, level Coastal Plain. The sediments of the Coastal Plain were originally deposited in flat layers, and the topography stays fairly smooth because the soft sediments erode easily and uniformly.

Where rivers and streams spill out of the steep Piedmont and into the low Coastal Plain, rapids and waterfalls are common. Thus, the boundary between the two provinces is called the Fall Line or Fall Zone. Many early American colonists settled and founded cities near the Fall Line because the falls marked the boundary of easy river navigation from the ocean. The falls also provided power for

Above: Rock Creek's water levels once affected visitors' access to the Zoo. (Photo by NZP Graphics)



Zoo visitors can see across Rock Creek to Mount Pleasant, which sits on the same 200-foot terrace as the Education Building. (Photo by NZP Graphics)

mills, and later, for factories. Today, the Piedmont is still one of the most densely populated areas in the country, with New York City, Trenton, Baltimore, Washington, Richmond, Raleigh, and Columbia all lying on or near the Fall Line.

The Fall Line

The Fall Line through Washington roughly runs along 16th Street, a little east of Rock Creek. To the west of 16th Street lie the metamorphic Piedmont rocks, and to the east lie Coastal Plain sediments. This explains the steep hills of Northwest Washington, which contrast with the lowlands of the southeastern part of the city. Other contrasts between the two regions become clear on a map: Rock Creek runs swiftly through a steep, narrow, twisted valley in the resistant rocks of the Piedmont, while the Anacostia River flows slowly through a flat, broad, straight channel in the easily eroded Coastal Plain sediments. And the Potomac widens noticeably at Theodore Roosevelt Island as it crosses the Fall Line into soft Coastal Plain deposits.

Most of the Zoo sits on hard Piedmont rock cut by Rock Creek. This tributary of the Potomac cradles the southern end of the Zoo in its steep-sided valley, making strenuous walking for visitors. Hiking out of Beaver Valley—which channels water into Rock Creek—can tax even the fittest of Zoo visitors on a hot summer day.

Rock Creek is also partially responsible for the impressive view northeast from the Connecticut Avenue entrance: From the Glockenspiel in front of the Education Building, visitors can see about a mile across the valley, all the way to the Mount Pleasant neighborhood. The Zoo entrance and Mount Pleasant sit on what was originally the same 200-foot plateau; now Rock Creek bisects the plateau, providing the present view.

Terraces

Washington is built on a series of such plateaus, or terraces, which are of different ages and elevations. Some date from about five million years ago; others are much more recent. They range from roughly 40 to 400 feet in elevation. Each terrace originated as a wide river bottom—gravel and sand laid down in fairly flat layers by either the Potomac, its tributaries, or their ancestors. Then, as the river cut deeper in response to falling sea levels, or the land rose higher due to local uplift, the flat river bottom was eventually left high and dry. This pattern continues to the present day. Therefore, high terraces, farther away from the present Potomac, are older than the lower terraces near the river.

Most experts recognize at least four distinct terraces in Washington; others count as many as seven. Identification is tricky because the old terraces have been cut through by rivers, eroded by wind and rain, shaken by movements in the earth, and most recently, modified by development.

The terraces extend like broad steps away from the Potomac. Theodore Roosevelt Island and E Street sit atop a 40-foot river terrace. Florida Avenue, itself on a 100-foot terrace, runs along the foot of another, about 170 feet high. Originally named Boundary Street, Florida Avenue formed the northern edge of L'Enfant's new city, built on the flat and easily farmed Coastal Plain. Today's drivers are treated to an excellent view of the old part of the city while driving south on 16th Street near Meridian Hill Park, just before descending from the terrace and reaching Florida Avenue.

In the northwestern part of the city, Reno Reservoir perches at 420 feet on the highest terrace in the District. Many springs, some of which contributed to pre-Civil War Washington's water supply, flow from the walls of this terrace. Water seeps out of the walls where the overlying terrace gravels meet the Piedmont rock below: The rain water percolates down fairly quickly through the gravels, but is forced out when it hits the impermeable Piedmont rock. Though the springs no longer contribute to Washington's water

Rock Creek flooded the Zoo during Hurricane Agnes in 1972. (Photo by NZP Graphics)

supply, the city still stores water (drawn from the Potomac) on top of the terrace, in Reno Reservoir. Because it's the highest spot in the city, water can be transported all over Northwest Washington by gravity.

At the Zoo, the isolated outcrops of terrace gravels that cap hilltops attest to the presence of ancestral Rock Creek or the Potomac here about a million years ago.

Flooding

Modern Rock Creek continues to dictate much of the Zoo's geology. Not only is it responsible for carving the steep-walled valleys here, but it sometimes affects the Park more disastrously—with floods. In 1972, Hurricane Agnes flooded the Zoo, putting the shop building, the boiler room, and the transportation building under seven to eight feet of water. In addition to extensively damaging the shop buildings and their contents, the flood destroyed half the contents in the hay and feed barn and uprooted 173 trees. The waterfowl in the lower ponds came within an inch of being able to float right over the top of their fences. Only one animal, a young wolf, came close to drowning. Then-director of the Zoo, Dr. Theodore Reed, stripped off most of his clothes and jumped in the wolf enclosure in time to save the wolf.

Geologists call the Hurricane Agnes flood an 85-year flood, because a flood of that magnitude will occur on an average of about once in 85 years. Data from work done by James O'Connor, City Geologist and Associate Professor of Earth Sciences at the University of the District of Columbia, indicate that Rock Creek's water level would rise 20 feet above the present bank at the Zoo's southern entrance during a 100-year flood. Even during a 25-year flood, the water level would rise about 15 feet.

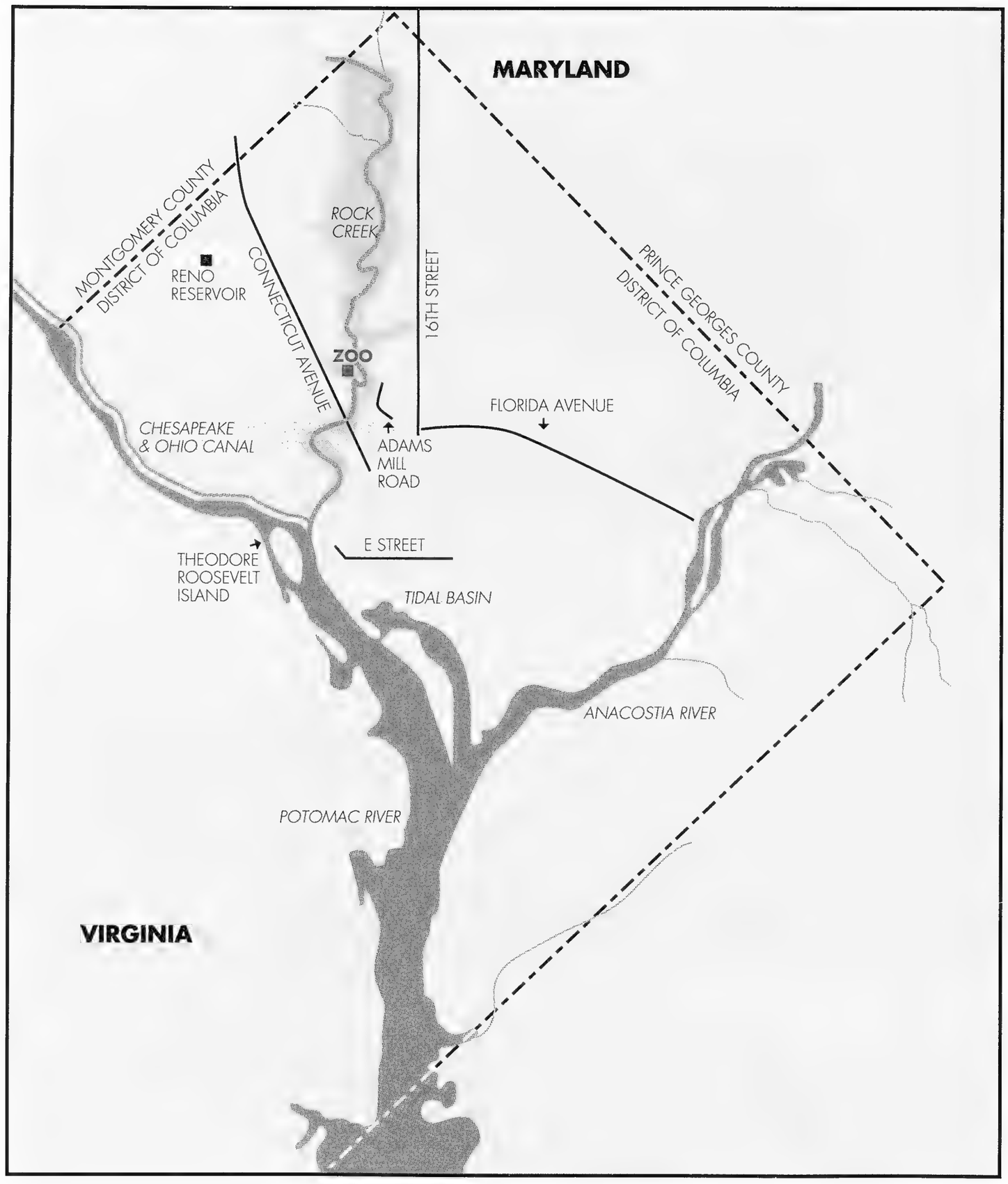
Before the late 1960s, visitors in cars (or buggies) had to pay much closer attention to water levels than today's visitors do. In order to cross the cement fords located at the southern and northern ends of the Zoo, drivers needed low, or at most, average waters. Otherwise, cars would be swept off the fords and into the creek. Of course, less adventurous motorists could always enter either at Connecticut Avenue or Harvard Street.

Tectonics

Water and the Fall Line have not been the only forces shaping the Park. Tectonics, or movements within the earth's crust, also affect the Zoo's geology. Within the Zoo, there are at least seven faults—areas where two blocks of earth have slid past one another. Most of the faults are hidden underground. But the most famous one, located at the Adams Mill Road entrance, is actually on exhibit! Geologist N. H. Darton had a cage put around the exposure of the fault in the 1920s to save it from vandalism and other destructive forces. Since then, it's been called Darton's fault. The exhibit cage has done its job as far as human interference goes, but it hasn't kept out 60 years of natural weathering which has partially obliterated the fault. A big tree root follows the weathered, indistinct fault and helps delineate it.

An interpretive sign within the cage says that sometime within the last 70 million years forces in the earth pushed old metamorphic Piedmont rocks over much younger Coastal Plain sediments. Geologists now think that the fault occurred much more recently—within the last several million years—and that the upper layer is probably river terrace gravels, not Coastal Plain sediments. Though Darton's fault occurred relatively recently on the geologic timescale, no earthquakes have been recorded in the District in historic times.

Geologists discovered another fault when they analyzed drill cores taken during the 1960s construction of the Rock Creek Parkway tunnel, at the southern end of the Zoo. When they compared different cores, they found that the elevation of some rock layers didn't match up from core to core. From this they inferred that a fault ran between the areas where they



had taken core samples. Ten years ago, construction of the Lion-Tiger Exhibit temporarily exposed another fault. And in the early 1980s, construction for the Metro's Red Line uncovered yet another fault just north of the Connecticut Avenue entrance. Most of the faults in the Zoo's bedrock probably occurred around the same time as Darton's fault—within the last several million years.

Evidence of other tectonic activity can be seen in the convoluted shape of Rock Creek at the Zoo. The creek follows sets of parallel cracks in the underlying bedrock. Called joints, the cracks were produced millions of years ago by stresses deep in the earth, but no movement has occurred along their surfaces. (If movement had occurred along the joints, they would be labeled faults.) Joints form in mathematically predictable orientations to different kinds of stresses, resulting in sets of parallel joints for each episode of stress.

Because the crumbled rock within the joints is more easily eroded than the surrounding solid rock, the stream follows these paths of least resistance. Notice that the arms of the creek's U-shape around the Zoo are parallel. Joints affect the shape of most of the rest of Rock Creek as well—the map illustrates other sets of parallel stretches of the creek.

As early as 1933, R. S. Bassler, Head Curator of Geology at the U. S. National Museum, called the National Zoo a "geologists's paradise." More recently, two UDC geologists wrote, "The Zoo's foundation is a living physical geology textbook." Indeed, the Zoo offers many examples of how different aspects of geology affect landscape. The ancestral Potomac and Rock Creek have left behind the terraces upon which the Zoo and surrounding city are built. Rock Creek, flowing through Piedmont rocks, shapes the Zoo's grounds and poses flood threats. And tectonics have produced the Zoo's seven faults and the joints that give Rock Creek its distinctive curve around the southern end of the Zoo.

For those willing to look, the Zoo displays a lot more than just animals.

BUILDIN

Next time you visit the Zoo, look at the walls as well as the animals behind them. Many of the animal houses were built with locally quarried rocks. As you examine and compare the building stones used throughout the Zoo, you'll become familiar with some of the most commonly used varieties in Washington. And you may even find the stone that was used to build your own house.

As you enter the Zoo from Connecticut Avenue and follow Olmsted Walk, the two buildings below and to your right—the Delicate Hoofed Stock Building and the Panda House—are both made of local Potomac bluestone that is more than 500 million years old. Close up you can see grains of shiny mica, rusty garnet, and milky quartz in the metamorphic (altered) rock.

Once you're familiar with Potomac bluestone, you'll be able to recognize it as the predominant material in the Elephant House and Mane Restaurant. Many houses in Northwest Washington are also made of this rock, including the Old Stone House in Georgetown, built in 1765.

Although the main structure of the Elephant House is made up of Potomac bluestone, the arched doorways and corners are made of beige-colored Indiana limestone. Look closely at the limestone to see millions of tiny marine fossil fragments. Geologists call the rock fossiliferous limestone because it contains primarily fossils. Indiana limestone, the most popular building stone in the District, is used in the Washington National Cathedral, the Department of the Interior Building, and all the buildings in the Federal Triangle along the north side of Constitution Avenue from the Department of Labor at 14th Street NW to the Federal Trade Commission Building.

You can see more Indiana limestone in the arched doorways of the Small Mammal House. In front of the house, a patio of imported granite encircles the base of the anteater statue. In the polished granite, you can see large crystals of milky quartz, pink feldspar, and black biotite.

NG BLOCKS

As you continue down Olmsted Walk, the Reptile House will be on your left. This brick building features twin marble columns made of marble, a metamorphosed limestone that sometimes retains the marine fossils of the original limestone. Look for coin-sized fossils of extinct cephalopods, gastropods, and other sea creatures in the columns—acid rain has etched away pure carbonate from the exposed fronts of the marble, making the fossils stand out in relief.

Next door, the Monkey House showcases another local rock, Kensington gneiss (metamorphosed granite), also about 500 million years old. Kensington gneiss was named after the town of the Kensington, Maryland, where it was first described. Two old Kensington gneiss quarries are located near the Zoo: One is off Broad Branch Road a quarter of a mile north of Brandywine Street; the other is behind the Uptown Theatre in Cleveland Park.

Kensington gneiss, often called "the salt and pepper rock," contains grains of dark biotite and light-colored quartz and feldspar. Any corner rock of the Monkey House reveals how the black, shiny grains of biotite look different on either side of the rock: On one side you should be able to see how the flat biotite grains were aligned in response to pressure and heat during metamorphism.

Although most Zoo building stones are local, the rocks of Monkey Island are from West Virginia. These hard sandstone boulders, which weigh between one and five tons each, hold up well under the constant stress of gravity, rushing water, and inquisitive monkeys. And their gray color blends well with the appearance of Kensington gneiss and Potomac bluestone.

Many other rocks in the Park—like those in the seal, bear, and eagle exhibits—are not natural rocks, though some can fool a geologist at twenty paces. To make the fake rocks, workers spray real rocks with latex to form a mold, into which they pour concrete and fiberglass. Then, to heighten the illusion, they add cracks called joints.

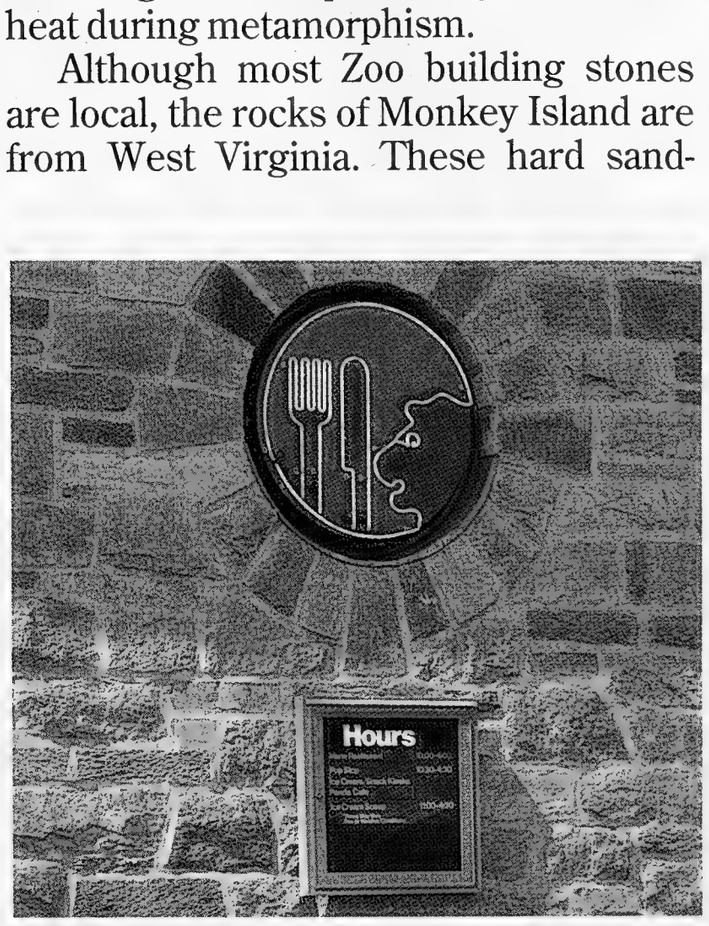
To compare man-made and real rocks, stop at the window in front of the Oriental small-clawed otters' pond in Beaver Valley. If you tap on the left side, you'll notice that the fake rock sounds hollow. Look closely at the texture, color, and shape of each kind of rock and compare.

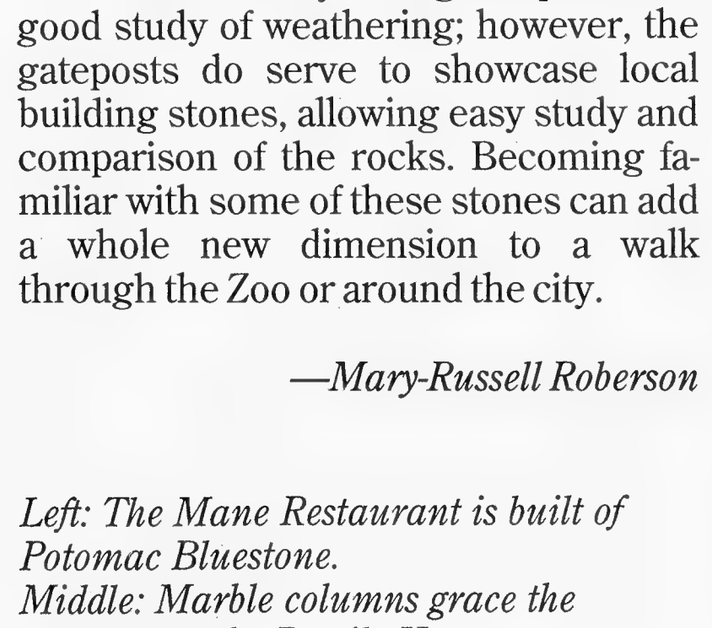
The Kensington gneiss used in Beaver Valley was excavated during construction of the Zoo and of the Cleveland Park Metro station; it was also used to build the waterfall up the hill in Beaver Valley.

To test your knowledge of Washington's local building stones, visit the gateways of either the Connecticut Avenue or Adams Mill entrance; both were built in 1932. In addition to Potomac bluestone and Kensington gneiss, the gateposts contain blocks of various sandstones and granites. Slabs of Aquia sandstone from Stafford County, Virginia, also used in the construction of the White House and the Capitol, cap both posts. The gateposts were built to demonstrate the effects of weathering on different kinds of local rocks. The faces of the posts are oriented to the four points of the compass, and each type of rock is oriented in different directions within the gates. For example, a layered rock may deteriorate more quickly if its layers are vertical than if they lie horizontally.

Unfortunately, records were never maintained closely enough to provide a good study of weathering; however, the gateposts do serve to showcase local building stones, allowing easy study and comparison of the rocks. Becoming familiar with some of these stones can add a whole new dimension to a walk through the Zoo or around the city.

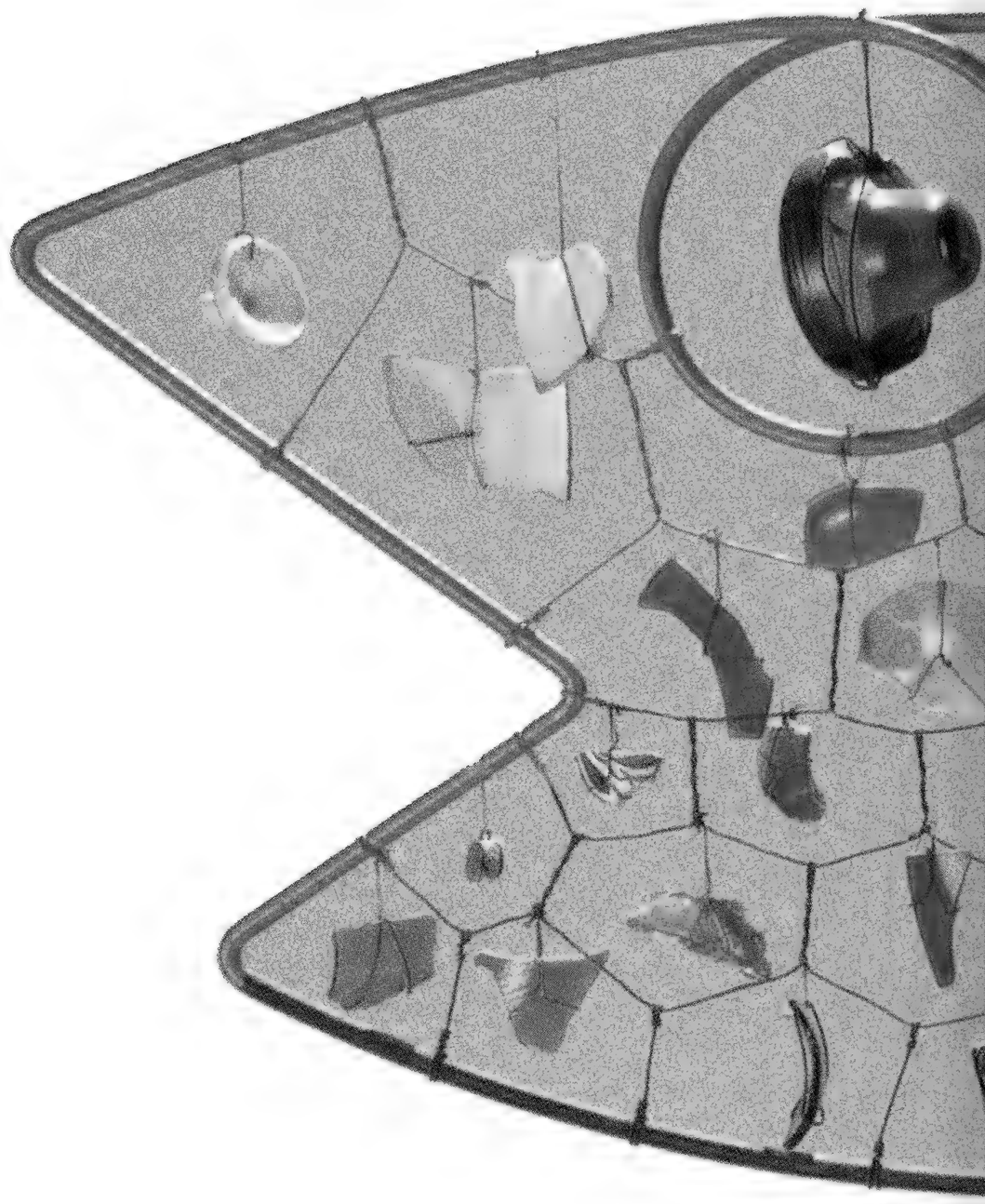
—Mary-Russell Roberson





Left: The Mane Restaurant is built of Potomac Bluestone.
Middle: Marble columns grace the entrance to the Reptile House.
Right: The Zoo's gateposts are made of various local rocks. (Photos by Jessie Cohen, NZP Graphics)

Menagerie Imagery



The relationship between culture and biology is an important theme of the BioPark

Lisa Florman Weinberg

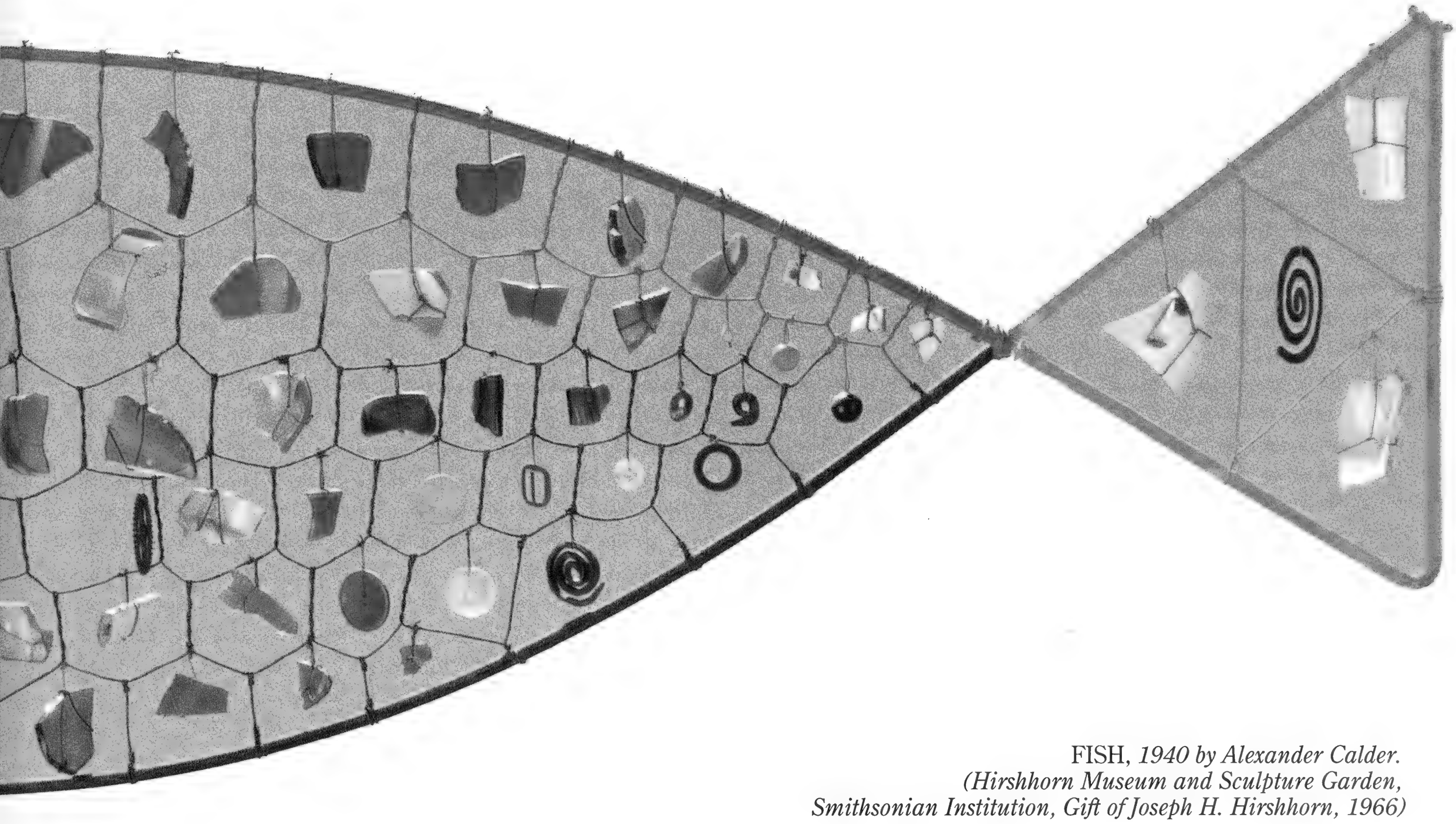
Early in his reign, which began in 285 B.C., the Hellenistic ruler of Alexandria, Ptolemy Philadelphus, staged a fantastic procession in honor of the god Dionysus. The procession was so enormous that it took a full day to pass by the city's stadium, and so extravagant that it made legendary the riches of Ptolemaic Alexandria. Among other things, the retinue included gigantic statues of gods and men, tableaux representing scenes from the life of Dionysus, and what must have been the greater share of the newly established royal menagerie: 96 elephants, 16 ostriches, 24 lions, 14 leopards, 12 camels, 2400 hounds, scores of sheep and antelope, peacocks, guinea fowl and an assortment of other birds, a "white bear," a giraffe and—perhaps most amazing of all to the assembled audience of Greeks and Egyptians—a rhinoceros.

The entire display seems to have been intended as an elaborate allegory associating the god Dionysus with the Alexandrian rulers, who (so the discerning onlooker would learn) had likewise traveled to and conquered the outermost regions of the known world. Yet, whatever its esoteric meaning, Ptolemy's procession was foremost a *visual* feast: animals and artwork together, given *to be seen*.

In the two and a quarter millennia separating Ptolemy's day from our own, art and animals have made many such joint appearances. The very frequency of their association suggests enduring similarities in our perceptions of the two. At the same time, even a brief survey of how artists have portrayed animals throughout history reveals changes in those perceptions of nature and of art, and allows us to see ways in which a given age differs from those that have preceded it.

For example, the large-scale menageries that had continued to be popular throughout the Roman Empire ceased with the end of the classical era. In the Middle Ages their place was filled to some extent by the illustrated bestiary—a sort of textual menagerie, combining elements of received natural history with a symbolism even more dense than that designed for Ptolemaic procession. For nature itself, in the medieval view of things, was a code through which God spoke to man. And if man were only careful enough in his reading and deciphering of nature, he would find all he needed to know of the divine order, the rules by which he could conduct his own life and thereby win salvation. "Every creature of this earth," began a poem by a twelfth-century theologian, "is like a picture or a book; it is a mirror of ourselves...." The medieval bestiaries, illustrated books of the creatures of this earth, made the metaphor complete.

The bestiary entry for an animal typically began with a contrived Latin etymology which provided the key to its significance. Thus we read that the beaver's Latin name, Castor, derives from *castrando* (castrating). The bestiary explains that



FISH, *1940 by Alexander Calder. (Hirshhorn Museum and Sculpture Garden, Smithsonian Institution, Gift of Joseph H. Hirshhorn, 1966)*

the beaver is hunted for the precious oil in its testicles; and that in order to save himself the beaver will bite off his own testicles and throw them at the hunter who then retreats, prize in hand. The bestiary, of course, drew a moralizing conclusion from the beaver's exemplary behavior: "Hence every man who inclines toward the commandment of God and who wants to live chastely, must cut off from himself all vices, all lewdness, and must cast them from him in the face of the Devil."

In the colorful pictures accompanying such entries, appealing as they did to a largely illiterate laity, each animal clearly displayed its characteristic trait. The beaver, for instance, was shown with a leg raised to reveal prominently his emasculation. These emblematic images became so popular in the late Middle Ages that the bestiary survived even after its moralizing was seen as little more than quaint.

Leonardo da Vinci, for example, late in the 15th century, compiled his own bestiary which borrowed from its illustrated predecessors the belief that animals—to a much greater degree than humans—display their character *externally.* This belief was of particular interest to painters, whose art shared with animals one profound limitation: deprived of speech, both made themselves known to people visually. In his bestiary Leonardo sought to turn this coincidence to advantage by establishing a system of correlations between the outward appearance of certain animals and their "inward nature," a system which could in turn be applied to humans. The assumption was that men and women share the temperament of the animal they most physically resemble. In a painting, then, a leonine man would be understood as courageous and magnanimous, following the character of the lion in the bestiary. The features of the woman in Leonardo's *Lady with an Ermine,* who so resembles the animal she cradles, are similarly signs of purity and elegance. "The ermine," Leonardo wrote, much in the vein of his medieval counterparts, "would rather die than soil itself."

Yet for all the conceptual affinities between the medieval bestiaries and Leonardo's own, there was of course a vast difference in the way each visualized animals. In part this was due to the fact that, although Renaissance works of art still tended to employ allegorical symbolism, it was no longer felt that nature did the same. At some point God's fundamental creative act had been recognized not as the arrangement of codes, but rather the formation of things. From then on an intense visual interest in the world reawakened—an interest in what things were, instead of what they meant.

Over the course of the next few centuries, the idea that art was based on the observation of nature became firmly established—almost a truism—culminating in the expression in the beautiful anatomic studies by the English painter George Stubbs. Stubbs tried to rid these works of all traces of allegory or pictorial convention. For him drawing based only on painstaking observation was a scientific tool, capable of revealing the secrets of

nature in all their wealth of detail. Thus it was Stubbs who was chosen by the anatomists John and William Hunter to illustrate their encyclopaedia of the animal kingdom, an eighteenth-century correlate to the bestiaries of the Middle Ages. Accordingly the artist frequented the zoos of England, themselves being transformed by the prevailing scientific interest from picturesque menageries into something much closer to the zoological parks familiar today. Stubbs's *Rhinoceros,* and other *Encyclopaedia* paintings that resulted from these visits, document a time and attitude which perceived relatively little tension between the scientific and the aesthetic; such works were considered beautiful *because* they were considered true.

In this century, the empirical approach has continued to thrive among scientific illustrators and many photographers of nature. However, modern artists have tended to view their project in radically different terms (—and here the appellation "modern" refers less to a specific time period, or even to a particular style, than it does to an aesthetic *attitude*). As the modernists see it, art has no need of reproducing the natural world; it can create its own worlds through the purely artistic means of color and form.

But if the aims of science and art have therefore largely parted company, animals have nonetheless remained of interest to both fields. And zoos have often mediated between the two. The modern artist Alexander Calder, for example, spent a great deal of time sketching in the Central Park and Bronx zoos. It was there that he developed what might be called his "zoo aesthetic": a love of color, gaiety, and variety in form and especially movement. Over the span of his career Calder created his own personal sculptural menagerie, from the suspended *Animobiles* which seem to move of their own accord, to the composite creatures known as the *Whatchamacalders.* It should perhaps surprise us little that animals remained a favorite subject of his work, despite its increasing abstraction, its emphasis of "pure" color and form. At a time when most figural representation had been banished from the modernist project as essentially irrelevant to the making of art, animal imagery survived. Perhaps this was because Calder, like so many before him, was trying to draw the analogy between art and animals as things which appeal most strongly to our sense of sight. Then too, as he said, "I want to make things that are fun to look at."

Lisa Florman Weinberg is in the doctoral program in art history at Columbia University.

Above:
Lady with an Ermine *by Leonardo da Vinci, c1485. (Columbia University Art History Slide Collection)*

Right:
Rhinoceros *by George Stubbs, 1790-91. (Columbia University Art History Slide Collection)*

FROM THE RIDGE OF THE FAN

The evolving BioPark is part of a network of greenways that connect open spaces in and around Washington with wildlands beyond

John Seidensticker

As far as I know, bird curator Charlie Pickett last February was the first to see the wild, white-tailed deer in the Zoo. He observed them in the small, forested basin just south of the Bird House while making early morning rounds. Throughout the spring the Department of Mammalogy received calls about escaped deer from startled Zoo employees and visitors alike who had sighted the white-tails roaming the Zoo's grounds. The appearance of the free-ranging deer sparked a discussion about releasing our own white-tails to roam the Zoo, but proximity to the Rock Creek Parkway and the potential danger to visitors and staff posed by our hand-reared male made such an undertaking much too risky.

Although problematic for the Zoo's horticultural staff, the beaver that have moved into and live in Rock Creek attest to the greatly improved water quality of the Rock Creek drainage system. The

*White-tailed deer (*Odocoileus virginianus*) travel via greenways to reach the Zoo.*
(Photo by Fiona Sunquist)

red fox that frequently roam through the Zoo at night, and have even denned in the Zoo's Beaver Valley, are a tribute to the tolerance of Washingtonians for wild carnivores. But the occurrence of free-ranging white-tailed deer on the Zoo grounds was a vigorous demonstration that the Zoo is not an island; it is linked with the "great American outdoors" through habitat corridors suitable for travel by the largest wild herbivore living in the Piedmont and Appalachian Mountains.

Rock Creek together with the Anacostia and Glover Archbold are corridors from the Potomac. The physiographic expression of Washington, as Ian McHarg so expressively describes in *Design with Nature*, begins on the flats where a great city meets a great river. The corridors extend out from the flats "like the ribs of a fan," linking the coastal plain with the Piedmont and beyond. Where the ribs are forested, they can be ribbons of habitat suitable for dispersing white-tails. These precious ribbons form increasingly valuable greenways.

What good fortune prevailed to make the existence of these greenways possible today? Saving forest habitats along these ribs from the Potomac dates from before the turn of the century, when considerable political attention was directed to concerns about water management, prevention of erosion, and provision of habitat for wildlife.

When Rock Creek Park and the National Zoological Park were founded a century ago, the concept of conservation stressed efficiency in development and production. Efficiency was closely linked with the wise use of material resources such as water, forests, and soil. For example, saving our native megafauna out of its natural habitat, for which the National Zoological Park was originally established, was viewed as an efficient approach to the problem. There was also much discussion at that time about the role of forests in efficiently maintaining a uniform flow of water for water power, navigation, and irrigation. Travel being what it was, the protected Rock Creek watershed was an easily accessible demonstration area in the nation's capital for foresters and conservationists seeking to convince the Congress of the value of forested watersheds.

Since then, our values and perceptions about conservation have undergone a transformation, gone beyond what Samuel Hays called "conservation and the gospel of efficiency." Increasing urbanization in the United States coupled with an increase in leisure time following World War II propelled a rising interest in the quality of life. Interest in conservation has turned into interest in the environment. Environmental quality has become an integral part of our national search for greater health and a higher standard of living. Where the ideas of conservation and environment come into conflict is where resources long valued mostly as material commodities become equally important and prized for their aesthetic and amenity uses.

As an ecologist who studies large mammals, I have been able to spend considerable amounts of time in some remote and wonderful wild places. This

meant that I had to walk and to like walking. Walking as a main mode of transport requires a shift in one's perceptions of scale in time and distance. Wilderness survival depends on an accurate assessment of the time it takes to walk between different locations under various weather conditions; miles don't really count, time counts.

Now, as a Zoo curator living in Washington, I find my priorities have shifted. The establishment and maintenance of remote wilderness areas and national parks remain very important to me, but recreational opportunities within walking distance of my home are what enhance the quality of daily life for me and my family.

Hearing from our house the tiger's moaning roar in the still of a Washington night and the early morning calls of the white-cheeked gibbons and siamangs is a wonderful link to exotic animals and far-away lands. On a day-to-day basis what has become essential for coping with the stress of urban life is that I can walk or bike to the Zoo along Rock Creek. When I reach the bend in Rock Creek near the Spectacled Bear Exhibit I am confronted with a choice: I can turn up Beaver Valley to my office or I can turn down Rock Creek, take the C & O Canal towpath to Harper's Ferry, turn south on the Appalachian Trail, and walk to the Smoky Mountains and see the thin green slice of the great eastern deciduous forests. Such a spectacular trip requires time, and when Saturday or Sunday is the time available, there are a host of local walking trips that loop back to the Zoo.

I think of it this way: The trail system within the Zoo is directly linked by foot-trail to the Appalachian Trail and beyond. These days I spend most of my time on

*Washingtonians are tolerant of carnivores such as red foxes (*Vulpes vulpes*) living in their midst. (Photo by Benjamin Boblett)*

the Zoo's trail system. As a curator, I see the varied physiographic expression of the Zoo as a stunning backdrop for the exhibition of the national collection of living animals. Most exhibits are clustered along the top of the moderately sloping ridge that extends from Connecticut Avenue to Lion-Tiger Hill, a promontory overlooking Rock Creek. Beaver Valley begins about midway down the ridge. This steep side valley, extending to Rock Creek, is a forested hollow on the southern exposure of the main Zoo spine. The ridge top is the Zoo's major travel axis: the ridge trail or Olmsted Walk, named in honor of the conservation pioneer and champion of the American landscape. (I think Olmsted would be pleased with the idea that the Appalachian mountains are linked with the Zoo via a greenway.) Beaver Valley, where many of our water-based exhibits are located, is a secondary travel axis in the Zoo. Pleasant forested paths link exhibits and connect the Zoo's major travel pathways, the ridge and valley trails.

The Zoo, located as it is, is part of a great network of greenways that provides the opportunity to become immersed in a great wild experience—or in a local adventure scaled to the time available. Just how important such opportunities are for Americans has recently been documented in the report of the Presidential Commission on Outdoor Recreation Resources Review, entitled *Americans Outdoors: the Legacy, the Challenge.* The Commission found that "walking for pleasure" was the most popular form of recreational activity for American adults. Nearly 80 percent of Americans live in cities and the Commission found that these Americans especially require access to natural sanctuaries within easy reach of home, for exercise, for rest, for reflection and renewal. The Commission envisioned greenways as a means of allowing every American easy access to the natural world: "... corridors of private and public recreational lands and waters, to provide people with access to open spaces close to where they live, and to link together the rural and urban spaces in the American landscape."

There are many opportunities to expand the greenway system: along river and stream courses, along utility corridors, along wildlife migration routes and flyway corridors, and along scenic roads and highways. With the nation's railroads shrinking at the rate of about 3,000 miles a year, there are approximately 120,000 miles of abandoned rail lines nationwide that could be developed as greenways. The Washington & Old Dominion Regional Park is a local example of the "rails to trails" conversion in which the old railroad corridor now forms foot, bike, and equestrian paths extending from Alexandria to Purcellville. More that one million people a year use this greenway.

The establishment of new greenways, as well as building the BioPark, underlies the process of creating an outdoor ethic, a personal involvement in the outdoors as an essential part of life. As the President's Commission put it: "It means a sense of appreciation for, and obligation towards the air, land, water and living things of the earth. It includes statesmanship, courtesy for others using the outdoors, and stewardship; our obligation to ensure future generations' enjoyment of our natural heritage."

John Seidensticker is NZP's Associate Curator of Mammals.

The Zoo is a link to exotic animals and far-away lands: bongo (Tragelaphus eurycerus) *exhibit at NZP. (Photo by Milton J. Tierney, Jr.)*

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